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REPORT OF THE DIRECTOR

Introduction

The annual report of the Institute for 1948-49 differed from the preceding reports in two important ways. It included a connected comprehensive account of the development of the Institute from the date of its foundation in 1905, and secondly, it gave a resume of the researches carried out at the Institute during three well-marked stages in its history, the first covering the period 1905 to 1936 when the Institute was situated at Pusa in Bihar, the second covering the period September 1936 to September 1945 after the move to Delhi, and prior to the third stage from October 1945 to the end of 1948 representing the period after the reorganisation of the Institute initiated in October, 1945. These two features are not repeated in this report, although a brief history of development of the Institute is given in the next few paragraphs for the convenience of those who may not have ready access to the report for report for 1948-49.

As in the case of the last report, the sections on administration and financial estimates included in reports prior to that for 1948-49 are omitted as not being directly concerned with the scientific activities of the Institute. They have been sent separately to Government.

DEVELOPMENT OF THE INSTITUTE

The Indian Agricultural Research Institute—originally known as the Agricultural Research Institute and College and later re-named successively the Imperial Institute of Agricultural Research, Imperial Agricultural Research Institute and Indian Agricultural Research Institute—was established by the Government of India in 1905 at Pusa, for advancing and developing the knowledge of the agricultural sciences. The laboratories of the Institute at Pusa bore the name of Henry Phipps, an American philanthropist, whose generous donation of £30,000 enabled the establishment of the Institute.

The Institute comprised laboratories and an experimental farm which included a cattle breeding section for the improvement of indigenous breeds of cattle. The agricultural college originally contemplated, however, was now established and the educational activities of the Institute were restricted to higher courses of training of the staff of the Provincial departments of agriculture. Post-graduate courses of two years' duration were instituted at Pusa in 1923. From November 1945, regular courses in the form of lectures, practical work, field investigations with regular examinations were introduced.

The move to Delhi

In 1934 the Institute at Pusa was wrecked by the disastrous earthquake of that year and faced with the question of rebuilding it, the Government of India decided to transfer it to New Delhi where by reason of its central and easily accessible location it was expected to perform more efficiently the functions for which it was established. The move was completed before the end of 1936. The present Institute popularly known as the ' Pusa Institute ' is situated about five miles to the west of the New Delhi Railway Station on an estate consisting of about 850 acres of land of which the farm area comprises about 350 acres. About 240 acres were recently acquired and about half of this area is intended for cultivation and the remainder for buildings. The laboratories and the residences are grouped around the Library which forms the centre of the lay-out. The Library possesses about one

hundred thousand volumes and receives almost all the important journals dealing with agriculture and the sciences basic to it. It is considered to be the biggest Agricultural Library in India and one of the best in all Asia. Recently one wing of the building has been fitted with an air-conditioning plant to save precious books from perishing under the extremes of climate.

The Research Work of the Institute

Investigations in the Division of Agronomy embrace wide variety of subjects including the building up and maintenance of soil fertility, mixed farming, the use of mechanised methods for cultural and harvesting operations, and the study of forage and fodder plants and grassland improvement. An important line of investigation has been study of the response of legumes to phosphatic manure, and the building up of soil fertility through legumes and phosphatic fertilisers.

Cattle breeding and management of cattle have always been a major activity of this Division and the fine Sahiwal and Tharparkar herds which have been built up are two of the best milch herds in the country. The Sahiwal herd which is located in the Institute is a great source of attraction for visitors. The Tharparkar herd is maintained in the Karnal Sub-Station of the Institute. Attached to the Division of Agronomy are sections of Agricultural Meteorology and of Statistics. It is proposed to expand both and to develop the latter into a separate Division.

The Division of Botany maintains living crop collections for its genetic and plant breeding work. More than twenty crop plants are being handled and some of the improved strains which have been produced, notably the ' Pusa ' wheats, have been of considerable value to the country's agriculture. Recent work includes the artificial induction of genetic variations and other cytogenetical studies. Plant physiological studies include a study of drought resistance in wheat and effect of hormones etc. on plant growth. A small section of plant introduction has been working since 1946 and a large number of varieties of economic plants are being maintained ; some of the more promising ones have been sent to the various States for trial.

The Division of Mycology and Plant Pathology studies disease-causing fungi, bacteria and viruses and actively collaborates with the Division of Botany in breeding disease-resistant strains of crop plants. Other studies include assessment of damage caused by important diseases of crop plants, and studies on fungicides. The Division of Entomology is concerned with the cataloguing of insects, the study of their life-histories, and the devising of measures for the control of pests which damage agricultural crops.

Work on locust control was done by this Division before it was transferred to the Plant Protection Organization few years ago. Studies on insect ecology and toxicology are also in progress.

Besides collaborating with the Division of Agronomy in agronomic research and carrying out a large number of plant and soil analyses for other Divisions, the Division of Chemistry is concerned with investigations relating to problems of soil fertility, the role of micronutrient elements, fundmental studies on clays and clay minerals, etc. In recent years soil survey work has been in progress and the Division of Chemistry has collected the available data on Indian soils and prepared a series of useful maps. A soil survey section is being developed in this Division.

The newly created Division of Agricultural Engineering is devoted to research on the improvement of agricultural machinery and implements with special reference to Indian conditions and the needs of the Indian peasants. A twin country plough has been designed which it is hoped would enable the output of work by the existing number of bullocks to be greatly increased.

Divisions of Agricultural Economics and Statistics have been sanctioned but have not yet been established.

In addition to the Divisions at New Delhi, the Institute had till April, 1950 a Division located at Coimbatore for sugarcane work. This station, with which the names of Barber and Venkatraman are associated, had become well-known because of the 'Co' series of canes which have been bred there. The Institute also has permanent substations at Karnal and Pusa.

SUMMARY OF MAIN RESULTS OF RESEARCH (1949-50)

AGRONOMY

Due to heavy rainfall of 14·72 inches in July 1949 sowings of *kharif* crops were delayed. This in turn delayed also rabi crops especially peas. The potato crop was adversely affected due to frost injury to foliage. The average yield per acre for major crops in the farm however, was maintained and in the case of wheat, oats, gram, maize and berseem showed improvement. (In attempts to get maximum yield of wheat, potatoes and gram under Delhi conditions the following have been achieved : wheat 41·9 mds/acre ; potatoes 373 mds/acre ; gram 14·8 mds/acre. In an experiment, " Plant composition as an index of fertilizer requirement ", the yield of maize with N $_{80}$P$_{80}$K$_{0}$ was 35·27 mds/acre). In verietal trials the following showed superior performances : Soybean, Clemson and Palmet, Sudan grass, Tift and Sweet ; Potatoes, Gola, Hy. 208 and Hy 209 ; Sugarcane : Co. 647, Co. 659, Co. 674 and Co. 680 ; Sweet potatoes ; B 219 ; linseed : NP 21 and Grasses ; *D. annulatum, P. oriental, C. mortances* and *P. repens.*

Manure and fertilizers

Nitrogenous manures and fertilizers, Russel Experiment : This experiment, the object of which was to assess the relative efficiency of different forms of organic nitrogenous manures and ammonium sulphate on the yield of wheat, was started on a new site in 1944-45. The results for the first four years ending 1947-48 were inconstant due to soil heterogenity. Both during the last and the present year green manure with sannhemp gave significantly higher yields than other treatments.

Effect of N, P, K. and Ca in different levels and their combination on wheat : For the third year nitrogen indicated significant response. Application of 40 lbs N/acre significantly enhanced the yield over control of 20 lbs N/acre. Other fertilizers did not show any effect. The interactions were also not significant.

Building up soil fertility through organic manures and inorganic fertilizers with and without legumes in rotation : The rotation followed was Wheat-Maize-Wheat-Maize and Wheat-Maize-Peas-Maize. The manuring is done only to rabi crops. The experiment which is now in its second cycle showed that in the case of wheat the response to application of nitrogen as ammonium sulphate and castor cake was more pronounced than F. Y. M. Rotation with the legume gave higher yield than without it.

Phosphate manures : *Phosphatic manuring of berseem.* The efficiency of phosphates in increasing the yield of berseem fodder is now proved. The object of this experiment was to test the comparative response of different forms each applied at the rate of 80 lbs P_2O_5 per acre ; ammonium phosphate proved to be the best.

Phosphatic manuring of berseem ; effect of boron and molybdenum singly and in combination on berseem : The object of this experiment was to assess the effect of boron and molybdenum singly and in combination on the fodder and seed yield of phosphate manured berseem under Delhi conditions. It has been found that the major phosphatic and ammonium sulphate treatments are significant in the first

three cuttings and the trace elements are not significant. In the fourth cutting however, it is the trace elements that are significant, and not the major elements. In the *bhusa* and seed yield, the trace elements only are significant.

Building soil fertility by phosphate manuring of berseem with Guar in rotation: The cropping scheme was Berseem-*Guar*- Berseem-*Guar* Berseem-*Guar*-wheat-wheat-wheat. Berseem in all three years had been differentially manured. *Guar* failed in all three seasons due to water logging. In the results of the first crop of wheat this year, residual effect is indicated.

Direct and indirect manuring of cereals in rotation with rabi legumes: This work was started in 1946-47 to study the response of *rabi* legumes, berseem, *senji*, *methra*, gram and peas, to phosphate manuring and compare the after-effects with direct manuring of maize and wheat. A general conclusion that can be drawn is that the residual effect of *rabi* legumes is quite effective in the case of the first crop following (*e.g.* maize) but when a second crop is followed after maize the fertility is not maintained and addition of N is beneficial.

Cultural experiments

Cultural experiment: *Effect of seed rate on wheat yield*: In an experiment in which different seed rates were tried with NP. 165 and C. 518 under irrigated and N. P. 4 under non-irrigated conditions the optimum seed rate was found to be 80 lbs/acre.

Cultural experiment on gram: In an experiment to see the effect of dates of sowing, spacings between lines and depths of sowing on the yield of gram 10″ spacing and 5 ″ depth of sowing were significantly superior to other treatments. There was no significant difference between different dates of sowing.

Multiple factor experiment on potatoes: This experiment started during 1947-48 with the object of studying the effect of different doses of K_2O (with NP constant) X seed size X spacing on the yield and grade of potatoes showed medium sized seed and 9″ spacing between tubers to be the best.

Weedicide experiment on wheat: Hand weeding gave better yields than spraying with Methoxone, a proprietory weedicide preparation.

Grasses and legumes (Agrostology)

Agrostology: Two more exotic species of grass have been added to the grass nursery. The legume collection under observation consists of 49 species, 20 indigenous and 29 exotic.

Improvement of Padlocks: An experiment to compare the effects of deferred grazing and controlled continuous grazing on the productivity and upon the health of the grazing stock showed that under a system of deferred grazing the animals gave very high individual gains of 40·41 lbs as against 29·2 lbs obtaining under continuous grazing.

Seed mixture trial: Oats and *Phalaris minor* in combination with three seed rates of *senji* and *Vicia* e.g. 1 : 0, 1 : 0·75, 1 : 1·5 indicated that grasses grown in association with legumes showed a higher protein content than when grown alone, which generally increased with increasing legume rate.

Cultural experiment on Phalaris minor: A seed rate of 8 lbs /acre was found to be optimum. There were no significant differences between methods of sowing. It was possible to take two cuttings under irrigated conditions.

Studies on Kundzu vine: It may now be definitely stated that the vine flowers twice a year normally after 3 years of growth. This year 325 seeds were obtained and germination tests showed that mechanical scarfication is necessary for success in germination.

Animal Husbandry and management

Cattle Breeding and management: The sale of surplus stock has been slow and the strength of the Sahiwal herd has increased considerably over the scheduled strength. The herd suffered from the after effect of "foot and mouth" disease. This was further aggravated by the "three days fever" which raged almost as an epidemic in the young stock. There were also a few cases of mineral deficiency. There were four deaths due to Johnes disease. The work in line breeding and selection, precalving milking, calf rearing and early maturity experiments continued. 26 heifers closed their lactation of which 10 have yielded more than six thousand pounds of milk in a lactation of ten months. Heifers '*Paprokee*' and '*Abajjai*' yielded 8006 and 9181 lbs. respectively. The cow Tamili yielded 12768 lbs. in her seventh lactation.

Collaborative experiments: The following collaborative experiments have been initiated in collaboration with the States: (*i*) trial of promising grasses and legumes (*ii*) comparative value of magnesium ammonium phosphate and (*iii*) relative value of sodium nitrate and ammonium chloride on paddy, wheat, sugarcane, cotton, jute and tea.

AGRICULTURAL RESEARCH SUB-STATION, KARNAL

Crop Section

Manurial experiments: The results obtained from one of the manurial experiments which were under progress showed that the direct application of bonemeal and F. Y. M., singly or in combination, on berseem gave good yields of the fodder crop. Their after effects on paddy were encouraging. In another experiment, the effect of manuring paddy in the nursery on its final yield after transplanting was studied. The treatment with ammonium sulphate at 200 lbs. N/acre gave an yield of 30·6 maunds/acre of paddy after transplanting and this was significant over 'no manure' giving an yield of 23·8 maunds/acre and also over the treatments 100 lbs. N and 400 lb. N/acre giving yields of 26·5 and 24·2 maunds/acre respectively.

In green manuring experiment, sannhemp and cowpeas gave significantly higher yields of wheat then after green manuring with *guar* and *moth*. The application of ammonium sulphate to wheat was conducive to higher yields than phosphate to the green manure crops. In another experiment, the application of phosphate to the green manure crop was found to give better yields of wheat than without its application to the green manure crop.

Varietal trials: In the wheat varietal trial, Punjab C.518, N.P. 775, C. 591, N.P. 710, N.P. 760 gave the best results. The differences among these varieties were not significant. Among four hybrids of potato, No. 209 gave the highest yield and

was significantly superior to Hybrids 291, 610 and Phulwa, the local variety.

Cultural experiments: Experiments were in progress to test the merits of seed bed preparation with tractor plough and bullock drawn inversion and non-inversion plough for wheat and paddy. The results obtained did not show significant differences among the cultural operations.

In gram cultural experiment, early and deep sowing with narrow spacing gave comparatively better yields, though not significantly.

Seed supply: Seeds of improved varieties of crops and setts of sugarcane were distributed. The total quantity supplied was about 3,463 maunds.

Cattle Breeding Section

Milk yield: The wet and overall averages recorded during the year were 20·2 lbs. and 10·7 lbs per cow per day respectively as against 18·6 lbs. and 12·0 lbs. recorded last year. Among cows and heifers which completed their lactations, two did over 9,000 lbs., four over 8,000 lbs., eleven over 7,000 lbs. and five over 6,000 lbs. of milk in 306 days.

Calf rearing: 56 female calves with an average birth weight of 48 lbs. and 48 male calves with an average birth weight of 52 lbs were born during the year. Their daily growth rates were 1·3 lb. and 1·2 lb. for male and female calves respectively upto the age of three months, 1·3 lb. and 1·0 lb. up to the age of six months and 1·0 lb. and 1·0 lb. up to the age of nine months.

Sale of Cattle: During the year under report, 35 animals were sold to the West Bengal Government, 23 to the Uttar Pardesh Government, 44 to the Rehabilitation Colony, Nilokheri and 10 by public auction.

AGRICULTURAL ENGINEERING

Activities in research work in the Division were limited due to the fact that facilities in the way of well-equipped workshop and office building were still not available and vacancies of a Mechanical Engineer and Assistant Engineer were not filled up during part of the year.

Test and trials of tractors and agricultural machines: During the year under report, a Fergusson tractor and a Zetor tractor were under trial in the Institute. The Fergusson tractor is one of the 30 secured by the Prime Minister during one of his visits to the U. K. A report on its performance and cost of operation has been prepared. The tractor is considered suitable for regular cultivation work.

The Zetor tractor made in Czechoslovakia was tried at the instance of Messrs Bhagwandass & Co., Delhi. The tractor is considered suitable for light reclamation and " follow up " cultivation work. It is a wheel tractor run on diesel fuel.

Data on the performance of the following machines were collected during the year for compilation and working out costs.

Caterpillar D-4 tractor ; Oliver ' 6 0 ' tractor ; Farmall ' H ' tractor ; John Deere ' G ' tractor ; Power Mower used for reaping operations ; Marshall Thresher ; Bullock Gear for operating stationary machines ; Threshers from Japan and Bullock Mowing Machine used for reaping grain.

Utilisation of rotted material from town refuse dump: A prototype machine for sieving manure (rotary screen) from town refuse dumps was fabricated and tried last year by this Division. A more comprehensive machine, which not only sieved manure but also elevated the sieved manure into lorries was fabricated and tried during the year. The new machine had a capacity of 8 times the prototype and had two

petrol engines for motive power. This machine was worked along with a tractor mounted manure loader at the Badli dump yard. While some modifications of the machine were needed, cost of operation by mechanical methods was found to be more than by the present manual methods.

Double Plough or Twin country plough: A double 'desi' plough was designed, fabricated and tried during the previous year. Clogging of trash, clods and shrubs to the frame work of the double plough had been observed. The frame work was redesigned during the year, with a view to avoid clogging. The new model has been fabricated and the field tests are statisfactory. The cost of material and labour in the new design is less than in the previous design.

Trial of Agricultural machines from Japan: With a view to examine and adapt machinery from abroad to Indian agriculture, a few manually operated machines were imported during the year from Japan. Trials of the following machines have been completed so far.

a) Two sizes of pedal-operated threshing machines from Japan were tried for threshing paddy. They were found suitable but the cost of operation by the machines has to be worked out.

b) Hand-operated straw cutter. This is a machine for producing Bhusa from wheat-straw. The output with the machine was found to be the same as by manual methods (using a Ghandasa).

Tests on water lift: Tests of output and efficiency were conducted on two models of Persian Wheels. The improved design supplied by a private party showed a slightly higher efficiency than the conventional type. Costs, quantities of material and labour charges in the manufacture of the improved design were less than of the the conventional design.

Devising machinery for groundnut cultivating and harvesting: At the instance of the Indian Oil Seeds Committee a survey of the existing methods in cultivating and harvesting ground-nuts in India was made. Details for research on developing bullock-operated machines for this purpose has been sent for consideration of the Indian Oil Seeds Committee.

Machine for plant breeding studies: A seed scarifier and a head thresher, which are small machines needed in plant breeding studies, were designed and constructed. Testing of these machines has to be continued.

Improved village chulla: Model of a "Herl Stove" or village *chulla* was constructed for purposes of demonstration. A damper door has been introduced in this model to regulate the rate of burning of the fuel.

Collection of Indian ploughs: With a view to examining the possibilities of standardisation or introducing a useful implement of one region in India to another, a start was made in the collection of country ploughs from different parts of India.

Agricultural Implement in India: After an investigation, a report on the present status of the Agricultural Implement Industry in India was prepared. This report gives the names of firms on regional basis indicating the products manufactured by them.

Measurement of irrigation water: V-notches were introduced and calibrated in the main channels leading irrigation water to the Institute farms, as a basis for further study of the water requirements of crops.

BOTANY

Plant Breeding and Genetics

Wheat: Further progress was made in the work on breeding, for the hills and the plains, wheat varieties resistant to all the three rusts; a number of promising selections have been made. The work is being done mainly at Simla under a scheme financed by the Indian Council of Agricultural Research.

Twelve newly-evolved N. P. wheat varieties were under trial, with the co-operation of the various state departments of agriculture, at 28 centres in India. In a majority of the trials, a number of these new wheats have done better than the corresponding local varieties. Among the 11 exotic wheat varieties under preliminary trial during the year, three, *viz.* E 228 (Egypt), E771 (U.S.A.) and E. 573 (Australia), appeared promising as regards yield and rust resistance.

In a varietal-cum-manurial experiment with 5 wheat varieties and 4 levels of manuring, no significant differential varietal response to the manurial doses was noticeable. The effect of the maximum manurial dose did not materially differ from that of the half-maximum dose, although both these doses were significantly more effective than "only nitrogen' and 'no manure'.

Collaborative work with the F.A.O. was undertaken for describing Indian wheat varieties for the preparation of World Catalogue of Genetic Stocks of wheat.

Linseed: Among the 35 newly-evolved rust resistant strains under trial at Delhi and at 10 other centres in 6 States, a number of strains have proved very resistant to rust and have outyielded the N.P. types and local varieties; ten of them had significantly higher oil content.

Rahar: N.P. 41 and 9 other recently bred hybrid strains of *rahar* were highly resistant to wilt under artificial inoculation of the disease.

Tomato: Six hybrid strains of tomato, evolved from the cross *Lycopersicon esculentum* (cultivated) × *L. pimpipellifolium* (wild) were distinctly earlier in maturity and had high vitamin C and sugar contents than a number of commercial varieties. They were under trial at 12 centres in the different states.

Hybrid maize: The work, being done under a scheme financed by the Indian Council of Agricultural Research, included the study of a large number of indigenous and foreign varieties and 34 double crosses obtained through the F. A. O. from U. S. A., Canada and Australia. Five of the American hybrids, among others, seem to be promising. Thirty-six double crosses obtained from abroad have been sent for trials to 25 centres in India.

Hybrid onion: The work on breeding hybrid onions was started; about 50 indigenous and exotic varieties were under study.

Tobacco: A number of selections of *rustica* tobacco have been evolved and were under preliminary trial with the cooperation of the Divisions of Agronomy and Chemistry. Four among them gave strikingly higher leaf-yield and stem and leaf ratio as compared with the control, N. P. 18. Three strains possessed distinctly higher nicotine content.

Cytology and Cytogenetics

Autopolyploidy: Work on the selection for higher seed fertility in autotetraploid *Brassicae*, linseed, sesame, chilli and gram was continued. Selection in the last three crops appeared ineffective. In *toria* (Brassica campestris var. *toria*) a

number of lines with increased seed fertility were obtained by selection and a number of *elite* bulk stocks have been built up from them. One such stock seemed to out-yield the diploid by about 10 per cent.

Sesame: A number of selections resistant under field conditions to the 'phyllody' disease of *til* have been obtained through inter specific hybridization between. *Sesamum orientale*, cultivated sesame, and *S. prostratum*, a resistant wild species. They are now ready for preliminary performance trials.

Wheat and allied genera: Cytology of a number of intervarietal, interspecific and intergeneric hybrids, including *Triticum-Agropyron* derivatives, was studied.

Crop Physiology

Drought resistance in wheat: A pot culture and a field experiment with 11 wheat varieties indicated that varietal differences as regards spikelet number and grain size persisted under different conditions of drought and also seasons. It appears worth while combining high spikelet number per ear with large grain size in varieties with high ear number; N. P. 52 and C 228 appear suitable varieties for the purpose.

Factors concerned with yield: In an experiment with 3 varieties (N.P. 710, N.P. 52 and N.P. 165) the contribution by the ear to grain weight was found to be the highest in N. P. 710 and the lowest in N. P. 165.

It was observed that on defoliation and puncturing peduncles of ears in all tillers in N. P. 165, N. P. 710 and N. P. 52, the yield of N. P. 165 suffered the most, the reduction being 40, 25 and 28 per cent respectively.

Influence of light and temperature on growth and development: It was found possible to raise three generations of 4 crosses of wheat between July, 1949—April, 1950 and two generations of 8 other wheat crosses between September, 1949—April, 1950.

In an experiment with three progressively delayed sowing dates (15-11-49—26-12-49) and 5 wheat varieties, Baluchistan 16, C 228, CPH 47, N. P. 165 and Pb. C. 591, the yield of Baluchistan 16 suffered progressively with delayed sowing, that of CPH 47 suffered significantly at the third sowing; those of C 228 and C 591 did not differ significantly with the different sowing dates.

Physiological aspects of plant nutrition: In an experiment with 3 levels of nitrogen and 3 wheat varieties (N. P. 165, N.P. 710 and N.P. 52), N.P. 710 absorbed the highest amount of nitrogen and N.P. 165 the least. N.P. 165 appeared to utilise nitrogen most efficiently.

Plant hormones: The effect of dipping cut leaf tips in different concentrations of idole-acetic acid on grain number per ear and on yield in the wheat varieties N. P. 165, C 228 and S 40 was studied; increased yields seem to result from increase in ear number rather than from increase in spikelet number.

Systematic Botany and Plant Introduction.

This permanent section of the Division commenced work during this year. The work on plant introduction is being done under an Indian Council of Agricultural Research Scheme since 1946.

Systematic botany: A large number of enquiries regarding identification and botanical nomenclature of plant specimens were attended to. A survey of weeds of crop fields around Delhi was commenced. The herbarium was being enlarged; a number of plant specimens were exchanged with those from Canada and Australia.

Plant introduction : One thousand, one hundred and sixty-seven samples of plant materials were received from foreign countries during the year for studying their usefulness under Indian conditions. The following are some of the promising materials which merit attention :

' Tie-Shin-Tun White ' a Chinese variety of sweet potato ; a variety of cowpeas, another of peas and a third (Bermuda Yellow) of onion from the Philippines ; Early Badger, variety of peas and Dixie Runner, a variety of groundnut from America ; two perennial grasses, *Pennisetum nervosum* and *Setaria sphacelata*, from Uruguay and Brazil respectively ; Brid's Foot Trefoil (*Lotus corniculatus*), a Canadian strain of perennial pasture legume ; a gigas strain of vetch (*Vicia sativa*) from Cyprus ; two species of *Phaseolus*, for green fodder, from Brazil ; an American variety (Bur clover) of medicks ; two Australian strains of sub-clover (*Trifolium subterraneum*) and a stylo (*Stylosanthes guyanensis*) from Brazil.

SUGARCANE RESEARCH

Plant collections

Spontaneum Expedition Scheme : Under a scheme financied by the Indian Central Sugarcane Committee, Orissa, West Bengal and North Bihar were explored during the year and 130 plants, including 73 of *S. spontaneum*, 24 of various species of *Erianthus*, 4 of *Sclerostachya fusca* and 1 of *Narenga porphyrocoma* were collected. In Orissa and West Bengal, 8 different species of *Sachharum* and *Erianthus*, not found in South India, were discovered. Two species of *Erianthus*, *E. fulvus* and *E. sikkimensis* and *Miscanthus nepalensis*, not found in the plains, were collected from the Darjeeling hills. These forms were collected from a very wide range of habitat. Agro-botanical data were being taken on all these forms.

With the addition of 90 new Co. canes, the live herbarium at the Sugarcane Substation, Karnal, which is being financed by the Indian Central Sugarcane Committee, comprised 839 collections including 501 Co. canes, 121 North Indian varieties, 90 *Spontaneums* and other exotic varieties and species. Observations on the morphological and anatomical characters were taken and a key to the identification of the Co. varieties in the collection has been prepared.

Breeding

Test crosses : With the favourable experience gained during the last two seasons regarding the types of seedlings obtained, a number of varieties were utilised during the year in making crosses on a large scale to assess their value as parent material. The parents so used include Co. 513 and Co. K. 32, which are the cultivated canes of Bihar and reported to be resistant to waterlogging, Co. 777 a heavy yielding cane and Co. 800 a good yielding cane with fair sucrose content. Crosses made between four tetraploid sweet sorghums obtained from the U. S. A. and pollen sterile varieties, like Co. 281, Co. 349 and POJ 213, gave only inviable seeds. Some more crosses were made between bamboo and four sugarcane varieties, Vellai, Co. 421, POJ 231 and POJ 2725. Twenty different crosses were effected using 13 forms of S. spontaneum, collected by the Spontaneum Collecting Expedition, and sugarcane ; the *spontaneum parents* were selected on the basis of sucrose content, resistance to drought, salinity and water-logging.

Chewing types : Four crosses were effected for obtaining soft-rinded, chewing types, Co. 603, Co. 743, Pundia and Fiji B were used as parents.

Commercial canes : Ninety new varieties, *viz.* Co. 746 to Co. 835 (both inclusive) were raised to the status of Co. canes during the year ; this represents the largest number so far released in one year. These, along with other, were sent to the various state experiment stations to enable them to have a wider choice of seedling varieties.

Tests for resistance to pests and diseases : In a study of the reaction of varieties belonging to the different species of *Saccharum* to the attack of the early shoot borer, Argyria, the varieties belonging to *S. sinese* appeared to be the most resistant, those of S. *officinarum* being the most susceptible and those of *S. Barberi* and *S.* spontaneum showing moderate resistance.

A large number of varieties belonging to *S. officinarum* and *S. spontaneum* were tested for resistance to smut under artificial inoculation of the disease ; many among those of both the species, did not show any external symptoms of infection and therefore appeared resistant. Similar tests of resistance to the Red Rot disease caused by *Collectotrichum falcatum* Went, indicated the resistance of some of the varieties belonging to the Co. 600 and Co. 700 series.

Cytogenetical studies

Interrelationship of Saccharum and allied general : For ascertaining the homology of the second set of 5 chromosomes forming the basic complement of *S. officinarum*, crosses were effected between the 50-chromosome derivative of *Saccharum* × *Sclerostachya* backcrosses and other allied genera such as *Erianthus, Narenga, Zea Mays*, etc. A seedling from one of such crosses, *viz.* S.G. 363/4 (2n=50) × Narenga (2n=30) showed $5^{III} + 10^{III} + 5^{I}$ at meiosis indicating homology between Sclerostachy and Narenga chromosomes and also 5 chromosomes belonging to the basic complement of *S. officinarum.*

S. Barberi, believed to constitute an amphidiploid complex between *S. officinarum* and *S. spontaneum*, was backcrossed to the latter two parental species with a view to breaking the amphidiploid constitution of *S. Barberi.*

The chromosome numbers of seven new varieties of *S. officinarum* were determined to be 2n=80. One variety of *S. robustum* contained 2n=72 chromosomes as against 2n=84 reported in the U. S. A.

Physiological studies

Control of flowering : These experiments aim at bridging the disparity in flowering between early and late varieties by suitable light, manurial and irrigational treatments. The early varieties, Co. 285 and Co. 421 were made to flower in as late as December by continous light treatment for 56 days.

In the manurial treatments, 100 lb. N. together with 285 lb. P_2O_5 extended the flowering phase of the early variety, Co., 285, to April. In pot experiments, the application of house dung manure tended to induce early flowering by about 20 days.

Botanical studies

Taxonomic significance of the occurrence of starch in stems of Saccharum : Observations during the year confirmed last year's finding that the presence or absence of starch in fully formed internodes is a definite specific character. From an evolutionary point of view, it would appear that (i) *S. Barberi*. being a *S. officinarum* × (*S. spontaneum*) complex, obtained its character of the presence of starch form the spontaneum parent ; (*ii*) the absence of starch in *S. officinarum* varieties suggests a probable origin from *S. robustum* or *Sclerostachya* or *Narenga* and (*iii*) the presence of starch in some selfed progeny of *S. officinarum*, as also in some of its intervarietal crosses, was probably due to some starch accumulating forms, *e.g.*, Erianthus, having entered into the *S. officinarum* complex.

Further studies on the cell size of leaf and earliness in maturity confirmed last year's observations that, while the difference in size of stomata between early and late varieties was not significant, the size of the bulliform cells showed a marked difference, they being considerably larger in the late varieties.

Chemical studies

The chemical studies included the determination of chemical constituents in the newly released Co. canes and the effects of soil conditions on growth and quality of cane varieties. In the latter study, the previous year's findings, that the juice quality of canes from wet lands were superior to that from garden land, were confirmed. Studies undertaken to estimate the available nitrogen (ammonia and nitrate nitrogen) showed that, though there was not much difference in the total nitrogen beween the two types of land, the nitrate nitrogen content was strikingly greater in the garden land.

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Agricultural Chemistry

Fertility building experiment: A berseem-guar rotation is being followed for 3 years in which the berseem crop is fertilised with 50 and 100 lbs P_2O_5 per acre as super with and without 80 lbs of K_2O as potassium sulphate. The analyses of berseem crop (1948-49, 3rd year) generally confirmed the previous year's results. The phosphatic manures increased the general uptake of P_2O_5 (average 38 per cent over control) but additions of potash seem to diminish it (average 10 per cent over control). The 3 years' results indicate a rise in the fertility of the plots as indicated by the increased recovery of the phosphate. The wheat crop following the three years' rotation of berseem-guar, however, showed no significant difference in yield.

Where legume was not introduced (wheat-maize rotation) in a general cropping procedure, a decrease in nitrogen (by 7 per cent) and available P_2O_5 content (by 22 per cent) of soils was observed even when N, P, and K were supplied to soils through manures while introduction of legume (wheat-maize-peas-maize) increased the available P_2O_5 content of all soils under manual treatments (average 44 per cent over control).

Studies on green manure plants: Loppings and leaves of wild leguminous plants and trees have been found to contain manurial ingredients in appreciable quantities comparable to the cultivated green manure crops.

The following different varieties of rabi leguminous crops are being examined for their comparative values for green manuring purpose: Senji, Berseem, Field peas, Lentil Gram, Methra and Lathyrus sativa. Applications of phosphate to these markedly improves the yield (by 10-70 per cent) as well as phosphate contents of these crops. Berseem received two cuts for fodder. The third cut buried, as green manure contained still the highest amounts of nutrients (110 lbs N, 21·0 lbs P205 and 84·0 lbs K20 per acre).

Soil Fertility

Raised plot lysimeter experiment: Phosphate applied at the rate of 200 lbs P_2O_5 per acre to berseem in the 2 years—4 course rotation of berseem-Cowpea-Wheat-Cowpea had its residual effect in increasing the yield of cowpea by about 157 per cent. In the purely cereal rotation the yield of wheat (Rabi 1949-50) was maximum with N + P, followed by P followed by N.

Micronutrients

Minerol deficiencies in citrus : Soil and plant samples were collected from Jullunder and Attari in the Punjab (I) and from Coorg. The symptoms of deficiency diseases in citrus in the Punjab (I) were found to be mottling *i.e.* yellow areas in between the veins. The affected plants had a bushy appearance and the leaves showing deficiency were much smaller and narrower in size. In Coorg the symptoms observed were yellow intervenal chlorosis, the affected leaves being small, pointed and narrow.

The soils from Punjab (I) have a low base exchange capacity and the organic matter content is nearly the same in both healthy and diseased ones. Diagnotic injections and spray treatments carried out in Attari and Jullunder showed a response to Zn.

Work on grasses, forage crops concentrates and mineral feeds : 16 glass samples at three different stages of growth (*i.e.* young ; preflowering and flowering) from I.A.R.I. grass nursery, five forgage crops, nine concentrates, three mineral supplements and one mineral mixture were analysed for cobalt and copper. It was observed that all the grasses are sound in the young stage but some at the flowering stage are either bordering on the marginal side or become deficient. All these grasses show a gradual decrease in their copper and cobalt contents with increasing age. All the forage crops studied contained sufficient amount of Co and Cu. The legumes are the best with respect to such elements. The concentrates are quite good on Co contents but their Cu values are marginal or sound. The oil cakes are considerably rich and will work as very good supplement for poorer qualities of cattle feeds. Chalk powder is very rich with respect to Cu and sound in Co. Sambar salt and rock salt have marginal values for Cu and sound values for Co.

Soil Survey

During the year under report soil survey for land utilisation have been extended to selected areas in Delhi District. A reconnaissance soil survey of about 4,500 acres was carried out at the request of Bhopal Sugar Industries, Sehore, Bhopal. A detailed soil survey of about 30 acres farm area of the Central Potato Research Institute, Patna was also carried out.

Minerological analysis of black soils from Padegaon, Indore, Jubbulpur and Bhopal show that soils of this region are composed predominantly of minerals of the Deccan traps, with admixture of minerals of Gondwana, Vindhyan and Archaen formation. Magnetite, epidote group, iron ore and pyroxene, minerals possibly derived from the Deccan trap, accounts for all the heavy minerals in Padegaon, about 80 per cent in Indore and Jubbulpur and 40-50 per cent in Hoshangabad (Powerkheda) and Bhopal (Chargaon).

Physical Chemistry

For complete information on the development and genesis of a soil it is essential to have a knoweldge of the nature of the clay mineral not only in the surface soil but also at different depths throughout the profile. With this object in view, three typical soils profiles collected from different localities, *viz.*, (i) black soil from Indore, (*ii*) black soil from Padegaon and (*iii*) Delhi soil from the National Physical Laboratory area, were collected and the electrochemical and related properties of hydrogen clay were investigated. The two black soils profiles show montmorillonite as the dominant mineral in their clay fractions, although (illite) to the extent of about 20 per cent is present in the Indore clays. In Delhi soil, a considerable amount of non-ex-changeable potassium occurs in the clay, the top horizon containing 6·55 per cent

while the lowest horizon (67—91") 3·28 per cent of K_2O. This suggest that illite is a major constituent of these clays, the top horizon comprising 80 per cent of it, and the lowest horizon 40 per cent. The other constituent which is most montmorillonite increases correspondingly with depth. This is confirmed by electrochemical studies of the clays.

Soil Physics

The results obtained in the first year of studies indicate that the introduction of grasses in farming increased the moisture retention to the extent of 20 per cent over control. Additions of organic manures like farm yard manure have further augmented the figure. The soils under study are sandy in nature with about 12 per cent clay and 70 to 80 per cent sand. Analysis showed that aggregates less than 0·2 mm size contained maximum of sand while those of 3·5 to 1·0 mm size contained a higher proportion of clay.

Soil Microbiology

Residual effect of superphosphates: Application of superphosphate at two levels 60 lb and 120 lb. P_2O_5 doses had their beneficial effect on the fifth crop of pea (the first four being pea, maize, pea and pea) not only on the yield but also on the total nitrogen fixed and the phosphate absorbed by the crop.

Preservation of Palm Juice: Experiments with aerated Nira (treated with CO_2 in soda water bottles) showed that addition of metabisulphite, 0·025 per cent was effective in supressing bacterial growth while sodium salicylate and sodium benzoate at the same strength depressed yeast growth.

Organic Chemistry

Oils and oil seeds analysis.—The semi-micro method for the determination of oil in oil seeds has been extended to other small seeds and it was confirmed that the result compare favourably with the conventional soxhlet extraction method. Taking into consideration the economy effected in chemicals, expediency of the method, reproducibility of the analytical results, the procedure is commended particularly in connection with breeding experiments.

Insecticides and Fungicides.—The compounds bornyl thiocyanoacetate, nopyl thiocyanoacetate (1948-49 report) and longifolyl thiocyanoacetate have proved to be effective insecticides against aphid.

Biochemistry

Chemical composition of wheat as influenced by manurial treatments: In continuation of the work reported last year, the samples of wheat grown in the permanent manurial and rotational experiments at Pusa were analysed for chemical constituents. P_2O_5 content of the grains increased when treated with phosphatic fertilisers, being maximum (1·16%) with NPK treatment and minimum (0·48%) with no manure.

Chemical composition of maize as influenced by manurial treatments: Maize crop of 1948-49 grown under different treatments in the permanent manurial experiments at Pusa has been analysed for ash, crude protein, ether-extract, nitrogen-free-extract, lime, phosphoric acid and phytin phosphorus. The maximum protein contents (10·27 & 10·17%) were found in the crop grown with F.Y.M. at 8000 lbs. and with rape cake at 20 lbs. nitrogen respectively.

Physics

Quantitative estimation of trace elements by the spectrographic methods: Manganese and boron are being estimated by copper electrode and the duplicates in each case

agree within 10%. Plant samples such as healthy and diseased citrus leaves etc. were analysed and the results obtained were found to lie within the limits of values obtained for those by other investigators.

Absorption spectrophotometric technique both in the ultraviolet and visible regions was set up and standardisation of methods for the estimation of vitamin A content is in progress.

MYCOLOGY AND PLANT PATHOLOGY

Systematic Mycology

The Indian Type Culture Collection maintained in this Division now consists of 783 cultures. The Collection continued to be a member of the International Federation of Culture Collections which is also linked to the UNESCO.

The mineral-oil preservation method was tested in the case of a number of fungi and it was found that ' Nujol ' and BOC 120 preserved the viability of some cultures for over 14 months. *Phytophthora infestans* (Mont.) de Bary was brought into culture and a medium consisting of maltose, peptone and carrot extract was found to be suitable.

Taxonomical studies on different genera such as *Glomerella*, *Valsella*, Nacrophomina etc. are being pursued.

Plant Pathology

Linseed : Out of 127 cultures of linseed tested for their resistance to 4 physiologic races of rust 107 proved to be immune or resistant both in seedling and adult stages. The wilt disease caused by *Fusarium lini* Bolley is favoured by temperatures ranging from 25-28°C and the death-rate tends to fall at temperatures above 30° and below 24° C.

Sugarcane : Twenty varieties of sugarcane out of 76 tested, reacted as resistant to the redrot disease. Out of 53 parent cane varieties tested for their resistance to sugarcane smut, 15 varieties showed less than 5% infection and may be regarded as highly resistant. Eight varieties out of 54 newly released by the Coimbatore Sugarcane Breeding Station also appeared to be resistant to the disease.

Bajra and Jowar : Experiments on the mode of transmission of Bajra smut have confirmed that the disease is airborne and that secondary infection in this smut does occur. That long-smut of Jowar is airborne has also been confirmed. Solar treatment of jowar seed was successful in appreciably reducing the incidence of grain smut.

Pigeon pea : Five varieties of pigeon pea out of 20 tested during the year under report proved to be resistant to wilt disease. Low incidence of pigeon pea wilt in sterilized soils has been explained on the basis of the activity of the associated microflora. The inhibition in cultures has been attributed to the metabolic products of bacteria belonging to the *Bacillus subtilis* group.

Fungicides : Tests conducted with various fungicides showed increased stand in maize of 13·2%, 11·6%, 10·8%, 9·5%, 8·9% and 7·0% in the case of copper carbonate, Mersolite-P, Barbak, Agrosan-GN, Aagrano and Spergon respectively. Covered smut of oats was controlled by treating the seed with copper carbonate, Aagrano, Semenon, sulphur and Agrosan, whereas the disease incidence in the untreated control was 17·3%. A hydrophobic colloidal sulphur spray was prepared and tested for the control of wheat rust. A dilution of 1 : 10000 of the spray induced lysis of germ tubes of rust spores.

Assessment of damage by fungi : With a view to assess the damage in the case of late blight of potato a correlation has been established between the leaf-area affected and the yield. Ninetyfive to 100 per cent infection of the leaf-area brought about a reduction of 60 per cent whereas 25-60 per cent infection brought about 40 per cent reduction in yield. A similar correlation has been worked out in the case of early blight of potatoes. It was found that 10-25 per cent, 40-50 per cent and over 75 per cent rust infection in wheat variety, Agra-Local, resulted in 11·5, 22·3 and 55·2 per cent reduction in yield respectively. In the case of sugarcane a reduction in yield of 29·3 per cent in the case of Co. 312 and 23·1 per cent in Co. 313 has been recorded as a result of smut infection.

Plat viruses

Viruses : Fall in virulence of Nicotiana virus 10 has been indicated by its passage through *Capsicum annuum.* (chillies). Phyllody in sannhemp has been indicated to be caused by a mixture of two viruses one of which is sap-inoculable, whereas the other has been identified as *Nicotiana* virus 10. Bottlegourd mosaic virus (*Cucumis* 2C) has been found to be carried symptomlessly in *Datura stramonium* and *Nicotiana tabacum* on the point of inoculation only and the virus fails to move into the system of the plant.

ENTOMOLOGY

Parasitology

Effect of low temperature on the egg parasite, Trichogramma evanescens minutum: To effectively control the attack of Caterpillar borers of stem and root of sugarcane it has often been found necessary to store parasitised eggs laid on cards at low temperature before they are despatched to various sugarcane centres for their liberation in the fields. It was confirmed that the parasitised eggs could best be stored without any adverse effect, either on their viability or sex ratio, for about a fortnight when they were four days old and kept at 10°—12° C.

Biological control of sugarcane pests : For the biological control mass breeding of parasites, such as Trichogramma *evanescens minutum* Riley and *Bracon gelechiae* etc. was continued. A culture of a parasite, *stenobrocon deesae* was maintained in the Division. Another parasite, *Bracon* (*Microbracon*) *chilonis* was found to parasitise also on the maize stem borer, *chilo zonellus* in the field. Preliminary attempts to breed the last mentioned parasite were fairly successful.

Influence of alternate hosts (*laboratory*) *upon the parasite Bracon gelechiae, a parasite of the* ' *potato tuber moth* ' : ' Pink bollworm ', sugarcane top borer, ' the gram leaf roller ', the castor leaf roller, ' the castor pod borer ' and the ' Jowar moth ' were tried as alternate hosts. It was found that the parasites bred on ' pink bollworm ' and ' sugarcane top borer ' were superior to those bred on other hosts both from the point of view of size and of fecundity. In regard to fecundity again, parasites bred on ' pink bollworm ' were superior to those bred on ' sugarcane top borer ' larvæ.

Bruchidæ : Studies on the morphology and external genitalia of this family of pulse beetles have revealed 5 genera comprising of 19 species, which have been described. Breeding of bruchids collected from pods of *Albizzia* sp. (a leguminous plant) has brought to light a new species of hymenopterous parasite, *Megastigmus.*

Chaetotaxy of the larvæ of *Plusia* spp., pests of gram, lucerne, etc. has been studied with a view to prepare a key to identify their immature stages.

Capsidæ : *Gallobelicus tenuis* Rent : Although the bugs feeding on tobacco and cucurbits in Delhi and several other parts of India show a good deal of variation,

a detailed study of their morphology and external genitalia indicated that they really belong to one species only. This was further confirmed by their capacity to interbreed.

Pentatomidae ; Eurygaster maura Linn : Hitherto this wheat pest was considered to be one species. Detailed studies on the morphology showed that what was considered to be one really constituted five varieties, viz., *maura*, *nigra*, *personata*, *pallida* and *picta*.

Ecology and Toxicology

Analysis of the bioclimatic data collected since 1942 has indicated that by converting the ordinary population figures into logarithmic scale most of the variations noted could be straightened out. Although there appears a strong correlation between seasonal variations on the one hand and population level and the factor of seasonal complex taken as a whole on the other, a separate correlation of temperature and humidity for the same was not well marked. It was observed that the natural correlation between trends of population and season gets disturbed in some regions. For example, whereas the climatograph of the period from middle of November to middle of January is retraced backwards from middle of January to middle of March the population level however instead of following backwards continue to decrease rather unaffected by the change in the trend of temperature and humidity.

Effect of temperature on insect susceptibility : From a study of the interactions between the effects of pretreatment temperature, continuous contact temperature, contact temperature and post contract temperature on the toxicity of insecticide dusts, the positive effect of pretreatment temperature was consistantly demonstrated. From theoretical considerations it appears that temperature coefficient of the entry of D.D.T. into the insects system is positive irrespective of the concentration.

Trials of insecticidal preparations against different pests : Eleven compounds prepared in the Chemistry Division were tested for their toxicity and nine commercial insecticides received from various firms were also tried against *Bagrada* sp., a serious pest of cruciferous crops.

The size of the insecticidal particles has been found to have a profound effect on the toxicity of both spray suspensions and dusts. Two factors seem to be involved in this effect : (*a*) the contact factor because the smaller particles fit in better in the contour of the insect body and (*b*) the draining off factor because the smaller particles remain suspended longer in the spray droplet when the latter falls on insect body and are likely to get drained off.

Miscellaneous items

Insect vectors of virus diseases : Castor white-fly, *Trialeurodes ricini* M. is a serious pest of castor crop in India and has been frequently observed in association with diseased plants. The bionomics and life-history of this species were studied in detail. Eggs were found to be laid in the middle or basal regions, between the major veins, on the undersides of the leaves. The immature stages are also confined mostly to this area which develop irregular depressions and subsequent curling. Transmission experiments were conduced on 10 one-month old healthy castor seedlings grown under insect-proof conditions by transferring to them 10-20 white-flies collected from diseased castor plants. Disease symptoms similar to those found on the plants used as source of infection appeared on the inoculated seedlings in 2-3 weeks and they became fully diseased in 4-5 weeks. Thus this white-fly proves to be an important vector of the virus disease of castor.

Studies on stored grain pests and their control : The biology of *Bruchus analis* and *Bruchus chinensis*, serious pests of stored pulses in India were studied in detail. A study of the biology of *Aplastomorpha calandrao* How., a chalcid parasite, showed that it was a parasite of the grub as well as pupa of both the bruchid species. The biology of the parasites under controlled temperature and humidity is under study. The biology of an egg parasite of the above bruchid species (*Chaetostricha Mukherjii* Mani) is also under study.

Survey of aphid population on potato crop : Aphid population was surveyed on potato crop during the period of January to April in and around Delhi. The species recorded were *Myzus persicae* Sulz., *Aphis gossypii* Glov. and *Aphis rhamni* Fons. The crop at the Institute, when the first observation was taken, showed that 2·5 per cent of the plants were infested by *M. persicae*, 2·5 per cent by *A. rhamni* and 62·5 per cent by *A. gossypii*. The maximum infestation was during the period of 3rd week of February to 1st week of March. *A. gossypii* disappeared first in the end of March followed by *M. persicae* and only a few *A. rhamni* remained on the last observation on 11-4-50. In January only 17·5 per cent of potato plant showed virus infection which increased to 90 per cent after two months.

GENERAL FEATURES OF THE REPORT

LIBRARY

The Library possesses about one hundred thousand volumes and receives most of the important journals dealing with agriculture and the sciences basic to it. The library is short of space now for the new books and periodicals which are being added constantly. Besides, one wing of the building is occupied at present by another library of the Indian Council of Agricultural Research.

The total number of publications received in the library during the year under report both by way of exchange and purchase was 2,637. Thirtysix new periodicals were added to the library during the current year. The number of books issued on loan was 6,224 out of which 1,187 were sent out to the scientific workers in the States and Universities. The visitors who made use of the Reading Room totalled 9,953 and they have consulted 126,534 books during the year.

References supplied during the year to the Ministry of Agriculture, I.C.A.R., State departments of Agriculture, Universities and individuals included the following :

(*i*) *Literature on* : Agriculture and animal husbandry legislation in India ; agricultural labour ; irrigation ; silage and silage pit construction ; rice ; tobacco ; species ; phosphatic manuring ; ammonium nitrate ; soil organic matter ; poultry ; solubility of silica in ammonia, toxicity of insecticides : origin of cultivated plants ; horticulture etc.

(*ii*) *Lists of books etc.* Books and journals on agriculture and allied subjects.

(*iii*) *Information on* : Weed control, growing grasses and legumes suitable for West Bengal etc.

Construction of buildings

During the year under review three bungalows, nineteen E-type and three H-type quarters were constructed for residential purposes. Besides, the forty newly built servants quarters were allotted to class III Government servants.

NEWLY ACQUIRED LAND AT DELHI

The newly acquired area of 241 acres is a *barani* land sloping from south-east to north-west. Sixty acres were marked out into ten 6-acres cultivator's holdings. These holdings have been allotted to the Cultivators of Village Todapur with a view to introduce intensive mixed farming practices evolved at Indian Agricultural Research Institute farm. Here the soil and water conservation practices were proposed to be introduced but during the year under report the cultivators desired to continue their original programmes.

Some of the area is traversed by gullies of various dimensions. Such eroded area had been marked out for work of Soil Survey Section of the Chemistry Division to collect information on soil erosion problems in relation to dry tracts.

About 100 acres were sown with *jowar* fodder. The crop was harvested and turned into silage or fed as fodder. In the absence of proper contour bunds it had not been possible to utilize it for regular experiments. Arrangements are in hand to fence a part of the area for agronomical experiments on Soil and Water Conservation. Details of a long term rotational experiment have been drawn up for layout in the proposed fenced area.

Advisory and Survey work

The Institute receives a large number of requests for supply of information, technical advice, manuscripts of research papers for refereeing, writing of reviews of scientific books, identification of different kinds of biological materials, analysis of samples, etc.

In compliance with the request of the Secretary, Department of Agriculture, Government of Madhya Pradesh, a scheme for the establishment of a parasite laboratory with details of equipments staff etc. was duly submitted.

Comments on the " Land utilisation survey in India " were sent to Professor P. C. Mahalanabis, Statistical Adviser to the Cabinet, Government of India.

The various advisory and survey works rendered by the different Divisions of the Institute during the year under report is briefly mentioned below :—

The advisory activities of the Division of Agronomy included giving advice to individual farmers, land owners, dairy men, public bodies and states on various aspects of crop cultivation such as berseem, potato, soyabean, some special types of grasses etc.; on manuring of different crops ; on breeding of livestock ; grassing of Hindan air field and providing lists of literature refering to dry farming ; farm machinery and livestock.

The Division of Agricultural Engineering answered a number of enquiries from the public on the availability and suitability of different kinds of tractors, threshers and other agricultural implements. Some of the enquiries also pertained to the selection of pumping sets for irrigation.

The Division of Botany received a large number of enquiries from different parts of India, relating mainly to correct botanical names of plants and their distribution, identification of plant specimens, and informatory notes on literature and cytological and breeding techniques.

A list of five hundred plant names intended for publication by the Editor, Dictionary of Economic Product was checked and advice on correct names and recent changes in nomenclature was given. Fourteen samples of seeds of Indian weeds, isolated in Fiji from the consignments of spices shipped from India, received through the Ministry of Agriculture, were identified. A list of important references of Indian work on *Sesamum*, maize, cotton and sunflower was prepared for communication by

the Ministry of Agriculture to the Indian Embassy at Ankara. The Ministry of Food were supplied with information regarding the botanical names of buckwheat, and some of the millets and were also informed of the non-toxic nature of the seeds of *Lolium perenne* isolated from imported food grains. A note was sent to the Secretary, Indian Council of Agricultural Research on insect-repelling grasses.

The East Punjab Railway Headquarters office at Delhi were given advice from time to time regarding the identity, uses, areas of production etc. of various plants and plant products. The Land Reclamation Officer, Punjab (I) was informed of the botanical name and also supplied with the detailed botanical description of *panwar* (*Cassia obtusifolia*). A sample of mustard seeds sent by the Municipal Health Department, Simla for examination was reported to contain 2·5 per cent seeds of Mexican poppy (*Argemone mexicana*) which are known to be poisonous. Information regarding cytological techniques and references to literature on this subject were supplied to the Botany Department of D.A.V. College, Dehra Dun ; School of Tropical Medicine, Calcutta and Botany Department of the Hindu University, Banaras. Dr. Jodha Ram and Sons, Dehra Dun were given information on dry farming, hydroponics and electrification of water for watering purposes. Short notes on the cultivation and other aspects of tapioca, water chestnut, *ramie*, linseed and *Eruca* were supplied to various correspondents. Besides the above, a large number of papers for publication were referred for various journals.

The Division of Soil science and Agricultural Chemistry during the year analysed in all 302 samples comprising soils, Tank silt, manures, fertilisers, feeding stuff, water, vegetable oils, butter, oil seeds, *Pyrethrum* etc. received from Governmental agencies and private institutions. Nine soil cultures of *berseem* and *lucerne* were supplied to farmers with necessary instructions for using them. Seven samples comprising soils, manures and fertilisers under different trade name, most of these received from the Ministry of Agriculture, Government of India, were under trial. Two of the samples, viz., " Novasol " a manure preparation by Prof. Bert of France and " Alphatrons " a radio active soil stimulant did not show any beneficial effects on the plant in pot culture experiments. The former was tried on wheat and peas while the latter was tried on Soyabean and paddy.

A rapid soil survey was undertaken at Jubbulpur at the request of the Central Waterways Irrigation and Navigation Commission, and a preliminary report has been submitted. In Schore (Bhopal) a reconnaissance survey was made of 4,500 acres of land belonging to Bhopal Sugar Industries, at the request of the Indian Sugar Committee. In Patna a soil survey of 30 acres and a farm area was also undertaken at the request of the Director, Central Potato Research Institute, Patna.

In all 18 notes were prepared on (1) Soil survey scheme for West Bengal State, (2) Manurial experiments on food crops with chilian nitrate, (3) Soyabean as food stuff, (4) Manuring of sugarcane, wheat and rice in India, (5) Effect of oilcake on wheat and paddy in India, (6) Effect of F.Y.M. on wheat and paddy in India, (7) Effect of N.P.K. and N.P. on wheat and paddy in India, (8) Different green manure crops in India, their yield and nitrogen content, (9) Blood meal manure, (10) use of Gypsum as manure and its use in land reclamation, (11) A note on Coffee manurial experiments, (12) Abstract of work done in India on improving the feeding value of rice straw, (13) Adulteration of mustard oil with Argemone, (14) Manuring of Potatoes, (15) Comparative manurial value of chillian nitrate and ammonium chloride, (16) A note on phosphatic fertilisers, (17) Response of crop to phosphatic fertilisers in India and (18) Note on the scope and manner of utilisation of chemical fertilisers and manures.

The Division of Entomology received in all 20 parcels of insect specimens from the different states of India for identification. These were identified and classified. In all there was a total of 93 species and this belonged to Coccidae, Coleoptera, Rhyncota, Orthoptera, Lepidoptera, Hymenoptera, Diptera and Mites.

Besides the above, 1 species of Acridiidae, 3 species belonging to Pyralidæ, Agromyzidæ, Chalcidoidea, 1 species of Lytta, 46 species of Jassidæ, 1 species of coprinæ, 4 species of orthoptera, 11 species of coleoptera etc. were identified on request, from different individuals.

Information was supplied to the correspondents on varied topics such as for instance (1) The pests of stored pulses, (2) Control measures on wooly aphis, (3) Life history, distribution and control of *Lytta picta* cast, (4) Control measures against brinjal fruit borer, (5) Distribution of various species of Meloideæ in National Pusa collection, (6) Information regarding the rock bee, *Aphis dersata* was supplied to Ministry of Agriculture, Government of India. 225 packets of seed samples either received from abroad or meant for export to foreign countries were examined and treated wherever necessary for insect infestation. Standing crops of wheat, barley, oats, peas, gram and potato of the Botany Division, Agronomy Division and at Karnal Sub-station were examined for freedom from Insect pests. Fortyone Phylloxera-free certificates were issued to M/S. G. Ghose and Co., Darjeeling for the export of orchids to Ceylon, U.S.A., Jamaica, Denmark, Trinidad, etc.

A number of hosts and parasite cultures were supplied to various organisations. A number of coloured plates of insect pests of agricultural crops were supplied to various correspondents.

In the Division of Mycology and Plant Pathology enquiries from all over India and abroad were attended to and also identification of pathogenic and taxonomic specimens and fungal cultures were made for research workers of various States and Universities at their requests. Information regarding literature and distribution of fungi was supplied as and when asked for. In addition, a number of scientific notes were written in connection with scientific enquiries. Over 250 samples of seeds and diseased plants were examined, treated and certificates of health issued whenever necessary.

SUPPLY OF PEDIGREE SEEDS AND STOCKS TO STATES

During the year under review the demand for N.P. seeds, specially the N.P. wheats, from different states was heavy. The supply fell far short of the demand. A brief statement showing the quantities of pure N.P. seeds supplied from the Institute is presented below.

Crop	Seeds supplied		Pusa Sub-station	Total
	Division of Botany	Division of Agronomy		
	lbs.	lbs.	lbs.	lbs.
Wheat	14950	17740	10224	42914
Barley	1930	330	3511	5771
Oats	2118	548	3149	5815
Gram	1188	874	1077	3139
Peas	1906	816	663	3385
Rahar	..	..	61·0	61
Mung	..	..	133·0	133
Lentil	..	..	107·0	107
Urid	..	..	19·0	19
Tobacco	..	..	3·0	3
Paddy	..	..	304	304

The Agronomy Division supplied pedigree cattle from Sahiwal herd to various indentors. The animals supplied were 27 bulls, of which 23 were young ones ; 23 Heifers and 31 cows. They were sent to Haringhat Farm, West Bengal ; Live Stock Officer, Hoogly, West Bengal ; Animal Husbandry Department, Uttar Pradesh ; Animal Husbandry Dept., Kaka Farm, Bihar ; Dairy Development Officer, Madhya Pradesh, Nagpur and to Trinidad Government, Union of South Africa.

Collections and Herbaria

Crop Plants : A large collection of different species and varieties of crop plants such as Wheat, barley, linseed, potatoes, chillies, pigeon peas, *Brassicas*, *Sesamums* etc., are maintained in the Institute. The collection of wheat is specially extensive. For purposes of exchange of materials and information with various plant breeding institutions of the world this Institute has undertaken collaborative work with the F.A.O.

Fungi and Micro-organisms : The Division of Mycology and Plant Pathology maintains a collection of fungi which includes 783 cultures. Being a member of the International Federation of Culture Collections, the Institute is collaborating with the International Federation in furthering its objects or promoting closer co-operation between the different culture collections of the world and the preparation of a world catalogue of strains. Cyclostyled copies of the catalogue of the above collection are available at the Institute for distribution. 78 cultures were supplied to different investigators in the country during the year under report.

Insects : Forty different species were added to the National Pusa Collection during the year. Many insect specimens were sent out to experts both in India and abroad for identification and study. While a large number of specimens were received during the year as donations from different Institutions of India and abroad, a large number was similarly donated by the Institute to other institutions. Considerable progress has been made in the catalogueing of insects and the catalogue of Oriental Bruchidae has been completed during the year.

SCHEMES

The schemes financed by the Indian Council of Agricultural Researh for the Introduction of Economic Plants, Improvement of the Maize Crop in India and Breeding Wheat for the Hills continued to function at the Division of Botany. The schemes on Nitrogen Fixation, Minor and Trace Elements of Plant Nutrition and on D.D.T. also financed by Indian Council of Agricultural Research are being continued in the Chemistry Division. The scheme on Preservation of Palmyra Palm juice, sanctioned by the Ministry of Agriculture, Government of India functioned till 23rd July, 1950.

At the Division of Mycology the following schemes are in progress : Scheme for Research on Diseases of Sugarcane, financed by the Indian Central Sugarcane Committee and a Scheme of " School of Research in Mycology ", financed by the Indian Council of Agricultural Research.

The Sugarcane Insect Pest Scheme financed by the Indian Central Sugarcane Committee which was in operation for several years in this Institute terminated on 31st March, 1950. Another D.D.T. Scheme financed by the Indian Council of Agricultural Research started functioning at the Division of Entomology from 24th July, 1949.

POST-GRADUATE TRAINING

Out of 138 applications seeking admission 52 students were selected by the Institute Council and admitted for training during the year under report. From these 52 students 2 did not join and another 5 students discontinued training after joining

the course. In addition there were 36 second year students who were under training and were allotted research problems covering the subjects of Agronomy, Agricultural Chemistry & Soil Science, Agricultural Botany, Entomology and Mycology. A list of theses submitted by the batch of students who have successfully completed their course of training in September, 1949 is given in Appendix II (a).

In addition to the regular post graduate courses 2 students were admitted for one year post graduate course in Genetics and Plant Breeding of Sugarcane (at Coimbatore) and one student for one year post graduate course in Plant Protection in the Mycology Division. A short course of training in Soil Science for six months was started during the year and 6 students were admitted for this course. One student out of these 6 however discontinued the training after attending the course for two months. One student underwent a short course of training in Cytogenetics in the Division of Botany.

Agronomy.—Eighteen students successfully completed their training during the year and received the Diploma of Associateship of Indian Agricultural Research Institute. Nineteen students were newly admitted for training from which one student from Madhya Pradesh discontinued the training in March, 1950. Theory and practical classes in Agricultural Engineering were held for the first year students of the Agronomy Division. These students also received a short course of practical training on farm and cattle management at the Agricultural Sub-station at Karnal. A short course of training, including few demonstrations of agricultural field machinery, was given to the teachers of the Central College of Agriculture during the month of June.

There is one Research Fellow attached to this Division engaged in research work.

Botany.—Fourteen students successfully completed the post graduate training and were awarded the diploma of the Institute. Nine students were admitted in the first year but one student subsequently discontinued training. The remaining eight students, on their completing the first year course of training, were promoted to the second year and have been allotted research problems.

One student underwent a short course of training in cytogenetics. There were two Research Fellows of the Institute engaged in Plant breeding work. There is one Research Fellow of the National Institute of Sciences of India engaged in research work on problems of embryo-culture.

Chemistry.—Six students successfully completed the training and were awarded the diploma of the Institute. Eight students were promoted to the second year and have been allotted research problems. Six students were newly admitted in the first year.

Five other students have taken a short course of study in Soil Survey. Besides, five other students of the East Punjab University have done research work for one year to qualify for the M.Sc. degree of the same University.

Entomology.—Six students successfully completed their training and received the Diploma of the Institute. All the first year students were promoted to the second year and engaged in working out their respective research problems. Seven students were newly admitted in the first year. One student is undergoing an one year course in Plant Protection.

At the instance of the Afghan Embassy in New Delhi and the Ministry of External Affairs, Government of India, three honorary research workers were admitted to work in this Division.

Mycology : Seven students after successful completion of their course received Diploma of the Institute. Fifteen students, nine in second-year and six in first-year, were under training. One student is undergoing the course of Plant Protection. Another student received a short course of training in this Division.

One Research Fellow was appointed by the Indian Council of Agricultural Research to work in this Division.

REGULATION OF EXPORT OF PLANT MATERIAL FROM INDIA

A suggestion was made to the Government for the formation of a Committee of Experts to advise on the measures to be taken to control the export of plant materials. This Committee consisting of the following was set up by the Ministry of Agriculture :—

1. Director, Indian Agricultural Research Institute, New Delhi (Chairman).
2. Inspector General of Forests, Ministry of Agriculture, New Delhi.
3. Superintendent, Royal Botanical Garden, Calcutta.
4. Prof. S. P. Agharkar, Poona.
5. A representative of the Indian Council of Agricultural Research, New Delhi.
6. Head of the Division of Botany, Indian Agricultural Research Institute, New Delhi.
7. Dr. D. Chatterjee, Systematic Botanist, Indian Agricultural Research Institute, (Secretary).

The Committee met only once on 27th May, 1950 and prepared the general principles governing the rules regarding the export of plant materials outside India.

EXPERT FERTILIZER COMMITTEE

The Ministry of Agriculture has formed the Expert Fertilizer Committee with the object of studying the utility of Chemical fertilisers in India and to gather further information regarding the use of fertilisers and organic manures by reference to Crop-soil relationship. The Chairman of the Committee is the Director, Indian Agricultural Research Institute and Head of the Division of Chemistry is the Secretary. The Committee met several times during the year, undertook tours and collected valuable data on the subject. The terms of reference of the Committee are as follows :—

(1) Collect all the existing data relating to the use of chemical fertilisers and its effect on the soil.

(2) Go into the whole question of the value and advantages of using organic manures mainly compost.

(3) Take the evidence of the Central & Provincial Government officers and practical agriculturists, wherever necessary.

(4) Suggest the best method of testing the chemical fertilisers either singly or in combination with organic manures with reference to the deficiencies in the soil in relation to the crop grown.

(5) Examine the suitable forms of nitrogen for various soils and crops in India

(6) Review the work already done and to draw a programme for the future.

(7) Take such other steps as may be needed to achieve the object of the Committee.

CONFERENCES AND MEETINGS ATTENDED BY THE MEMBERS OF THE STAFF

The Director attended a number of meetings and conferences both in India and abroad. Mention may be made of the following : United Nations Conference on the Utilization of Resources held in Lake Success, U.S.A. ; Meetings of the Board and the Executive Committee of the International Council of Scientific Unions held at Copenhagen, Denmark ; Committee Meetings of the Department of Research, Government of India ; Meetings of the Central Committee of Soil Science ; Governing Body and the Advisory Body meetings of the Indian Council of Agricultural Research Joint meetings of the Nutrition Advisory Committee of the Indian Council of Medical Research and the Vanaspati Research Advisory Committee of the Council of Scientific and Industrial Research ; Indian Central Sugarcane Committee Meetings ; Meeting of the Road Research Planning and Advisory Committee ; The Indian Science Congress held at Poona in January 1950 etc.

Agronomy : Dr. T. J. Mirchandani attended the following meetings and conferences during the year :—Indian Council of Agricultural Research meetings held in November, 1949 ; All India Cattle Show Committee Meetings ; Indian Science Congress held at Poona, January, 1950 ; Ad Hoc Committee on Black Soils of South India at Sholapur and Nagpur and Crops and Soils Wing meetings of the Board of Agriculture at Patiala. Shri P. M. Dahbadghao also attended the Indian Science Congreess at Poona.

Agricultural Engineering : The Head of the Division of Agricultural Engineering attended the meetings of the Indian Oil Seeds Committee and the Planning Commission meeting in June, 1950 to discuss the possibilities of improving Agricultural Implements in India.

Botany : Dr. B. P. Pal acted as a member of the Travancore University Commission held at Trivandrum during March, 1950. Drs. B. P. Pal, P. N. Bhaduri and D. Chatterjee attended the meetings of the Indian Science Congress held at Poona. Dr. N. Parthasarathy took part in the Meetings of the Crops and Soils Wing of the Board of Agriculture held at Patiala, March, 1950. Drs. B. P. Pal, N. Pathasarathy and P. N. Bhaduri also attended the meetings of the National Institute of Science of India.

Chemistry : Dr. S. P. Raychaudhuri and Dr. R. V. Tamhane attended the Soil Science Committee meetings of the Indian Council of Agricultural Research. Dr. Tamhane also represented India at the British Commonwealth Conference on " Plant and Animal Nutrition in relation to Soil and Climatic Factors " held in Australia between 2nd August to 15th September, 1949. Dr. Raychaudhuri also attended the meetings of Crops and Soils Wing of the Board of Agriculture and Animal Husbandry held at Patiala. The 37th Session of the Indian Science Congress held at Poona, 1950 was attended by Dr. Raychaudhuri, Dr. Tamhane and Dr. N. D. V.

Entomology : Dr. E. S. Narayanan and Dr. S. Pradhan attended the Third meeting of the ' Inter-departmental Insecticidal Committee ' held at Delhi in July 1949 and the Indian Science Congress held at Poona in January, 1950.

Dr. Pradhan also attended the " Statistical Annual Conference " held at Poona in December, 1949. Dr. Narayanan also attended the Lac Cess Committee meeting at Calcutta in July, 1949 and the Advisory Board and Expert Sub-Committee meeting at Ranchi during March, 1950. Together with Shri T. V. Venkatraman, Dr. Narayanan attended the Ad Hoc Expert Entomological meeting of the Indian Central Sugar

Committee held at Delhi in November, 1950. The Entomological Committee Meetings of the Indian Council of Agricultural Research held during March, 1950 and the Board of Entomological Conference and Agriculture meetings held at Patiala were attended by Dr. S. Mukherji and Dr. S. Pradhan and Dr. Narayanan respectively.

Mycology : Dr. R. S. Vasudeva attended the " Gram Wilt Sub-committee meeting " in February, 1950 and the Botany Committee meetings, both the meetings being sponsored by the Indian Council of Agricultural Research. He also took part in the Mycological Conference, the Joint Conference of Mycologists and Entomologists and the 8th meeting of the Crops and Soils Wing of the Board of Agriculture and Animal Husbandry held at Patiala during March, 1950. Dr. Vasudeva further attended the meetings, at New Delhi, of the Inter-Departmental Committee on Insecticides in July, 1950, meetings of the Oil Seeds Committee and together with Dr. B. L. Chona attended the meetings of the Indian Central Sugarcane Committee held in New Delhi. Dr. R. Prasada attended the 37th session of the Indian Science Cogress held at Poona.

VISITORS

During the year under review many distinguished persons visited the Institute. Among them were :

The Hon'ble Shri K. C. Reddy, Premier of Mysore ; Piyar Rangsit, Bangkok, Siam ; Shri Hanumanthaiya, Member of the Constituent Assembly, New Delhi ; H.E. the Prince de Ligne, Belgian Ambassador ; Dr. J. C. Ramchandani, Ministry of Agriculture ; the Hon'ble Ministers, In-charge of Medical and Public Health and Incharge of Food, Union of Travancore and Cochin States ; The Hon'ble Shri Hare Krishna Mehtab, Premier of Orissa ; F/Lt. W. Reid, V.C.B. Sc. (Agric.), a graduate travelling scholarship holder, Scotland ; Col. Edward Collins ; Shri K. L. Punjabi, I.C.S., Secretary, Ministry of Agriculture ; Dr. H. Mark, Director, Brooklyn Polytechnic Institute, Brooklyn ; Professor P. Auger, Director of the Department of Natural Science of the UNESCO at Paris ; His Excellency Mr. Sudarsan, Ambassador of Indonesian Republic ; Mrs. Beatrice Lamb, a delegate to the World Pacific Conference ; Prof. A.W. Ashby, Director, Institute of Research in Agricultural Economics, Oxford ; Sir Robert Robinson, President, Royal Society, London ; Prof. J. D. Bernal, London ; Prof. Englehardt, Academy of Sciences, Moscow ; Dr. V. Butrov, Academy of Sciences, Moscow ; Mohammed Drar, Ministry of Agriculture, Egypt ; Dr. D.L. Lobback, Belgium Congo ; Dr. D.E. Faulkner, Department of Veterinary Services, Kenya ; P. Siddi Jai, Department of Livestock, Bangkok, Thailand ; Dr. R. E. Turner, Yale University, U.S.A. ; Mr. Godwin Lewanika, President of the African Congress of Northern Rhodesia ; Dr. Clifford C. Taylor, Agricultural Attache to the American Embassy in New Delhi ; Shri R. K. Patil, Member, Planning Commission, New Delhi ; Dr. Norman D. Waters, University of California, Berkeley ; Mr. N. T. Mone, I.C.S., Joint Secrtary, Ministry of Agriculture ; Mr. E. S. Krishnamoorthy, Joint Secretary, Ministry of Agriculture ; New Delhi ; Kallur Subba Rao, M.L.A. (Madras), Member of the Constituent Assembly, New Delhi ; Dr. Monomohan Das, Member of the Constituent Assembly, New Delhi ; Mr. G. F. Man kodi, Director of Food Production, Saurashtra ; Mr. T.A. Abdulla, Minister for Food & Supplies, United States of Travancore and Cochin ; Mr. P.T. Chacks, Member of the Constituent Assembly, Travancore-Cochin ; Mr. D.K. Hingorani, Ministry of Education, New Delhi ; Mr. M. L. Lin Malaked, Ministry of Education, Bangkok ; Dr. P. V. Kepner, Extension Service, United States Department of Agriculture, Washington, D.C.; Dr. A. H. Moseman, United States Department of Agriculture, Plant Industry Station, Betsville, Maryland ; Dr. Norman Soong, Tokyo ; Dr. R.A. Bianchi, Hawaiian Sugar Planters' Association Experiment Station, Honolulu.

ANNUAL REPORT FOR THE YEAR 1949-50

DIVISION OF AGRONOMY

During the year under report the research activities of the Division were under the following heads : weather and crops ; varietal trials ; experiments on nitrogenous, phosphatic and potash fertilizers and their combinations and micronutrient elements, cultural and cultural *cum* manurial experiments ; agrostology and collaborative experiments with the States.

Weather & Crops : The record of meteorological observations is summarised below :—

Month	Mean temperature Max.	Mean temperature Min.	Relative humidity % 7 A.M.	Rainfall inches	Departure from normal	Mean wind velocity	Mean evaporation in inches in one day.
July 1949 ..	92·6	79·9	83·6	14·72	+7·29	4·91	0·3086
August 1949 ..	92·3	78·6	81·7	3·20	—1·78	4·22	0·2641
September 1949 ..	93·3	77·8	84·9	3·66	—2·15	3·37	0·2430
October 1949 ..	90·2	62·2	73·1	0·01	—0·38	2·84	0·2479
November 1949 ..	80·6	50·6	64·2	..	..	2·08	0·1885
December 1949 ..	71·8	41·4	75·7	..	—0·16	2·29	0·1305
January 1950 ..	70·8	43·7	89·0	0·37	—0·53	2·78	0·0949
February 1950 ..	69·7	42·7	82·0	0·52	—0·43	2·53	0·1321
March 1950 ..	81·2	53·9	78·1	0·59	+0·10	2·97	0·2125
April 1950 ..	97·5	67·9	46·7	0·03	—0·23	3·57	0·3996
May 1950 ..	103·4	76·3	42·0	0·39	—0·24	4·64	0·4925
June 1950 ..	104·3	82·4	53·2	0·93	0·85	6·09	..

Except for heavy rains during July, 1949, almost all the year round the rainfall was deficient. This rainfall in July delayed sowing of the *kharif* crops and this in turn delayed also *rabi* crops especially peas. Presowing (*rauni*) irrigation had to be given for *rabi* crops and the crops also required more frequent irrigation. In most of the months both the maximum and minimum temperatures were below normal. The potato crop was adversely affected due to frost injury to foliage. From July, '49 to March '50 the relative humidity was quite high. There was maximum wind velocity in July and minimum in November. July was more cloudy than other months. The rate of evaporation was maximum in May. The yield of *kharif* crops suffered due to late sowing and those of *rabi* crops because of low temperatures and deficient sunshine. Dry weather conditions in May favoured harvesting and quick threshing of rabi crops.

The average yield/acre for major crops of the farm during the year as also that of the previous year is shown below :—

Crop	Yield in mds. per acre 1948-49	1949-50	
Wheat	19·7	20·4	
Oats	21·5	22·7	
Barley	32·9	31·4	
Peas	17·7	12·9	(Late sown, 10th Nov. to 10th Dec.)
Gram	10·6	14·7	Damaged by hailstorm, on 14·3·50.
Maize	11·4	12·26	
Sugarcane	683·9	548·38	Includes the yield of ratoon expt. crop unmanured for study of residual effect.
Berseem	385·0	583	

Varietal trial (*i*) *Soybean* : A varietal trial to test the five early maturing soybean varieties selected from a preliminary trial of 24 U.S. varieties showed Clemson and Palmeto to be better than others :

Variety	Yield in mds/acre.		
A. Clemson	6·91		
B. Palmeto	6·50		
C. Creole	5·04		
D. Monetta	4·98		
E. Charlee	4·37		
C.D. at 5%	1·64	$\overline{AB}$	$\overline{CDE}$

(*ii*) *Sudan grass* : An yield trial under irrigated and non-irrigated conditions f U.S. varieties of Tift and Sweet and an acclimatized variety from Sirsa showed Tift and Sirsa to be superior to Sweet variety. These varieties behaved better under non-irrigated conditions :—

Variety	Total yield of three cuts in mds/acre	
	Non-irrigated	Irrigated
A. Tift	155·19	122·37
B. Sweet	86·40	93·34
C. Sirsa	158·62	136·69
C.D. at 5%	17·66	$\overline{CA}$ $\overline{B}$

(*iii*) *Potatoes* : In a varietal trial to test Hy. 208, 209, 610 and 290 against standard varieties of *Phulwa*, *Gola* and Darjeeling Red Round, it was found that the yield difference in varieties are highly significant :

Gola, 208, 209, 610, 291, D. R. R., Phulwa

Gola is however ordinarily not a high-yielding variety and the trial will have to be repeated before definite conclusions are drawn.

(*iv*) *Sugarcane* : Results of semifinal yield trial and final trials were : Co 647, Co 659, Co 674 and Co 680 superior to Co 453, Co 617 and Co 655. In ratooning capacity Co 537 superior to Co 312, Co 431, Co 453, Co 537, Co 620, Co 621 and Co 622.

(*v*) *Sweet potatoes* : B. 219 yielded higher as compared to Triumph, T.S.T. Red, B. 4306 and Local.

(*vi*) *Linseed* : NP 21, a standard variety yielded better than B. 5128, Dakota, Sheyenne, three rust resistant varieties from U.S.A. obtained through the Oilseeds Committee ;

(*vii*) *Grasses* : In a grass varietal trial with 14 different species : *D. annulatum*, *P. orientale*, *C. mortances* and *P. repens* showed very high yields.

Manurial experiments : *Nitrogenous manures* : (*viii*) *Russell experiment.* The object of the experiment was to assess the relative efficiency of different forms of organic nitrogenous manures and ammonium sulphate on the yield of wheat. The experiment was started in 1944-45. The results for the first four years ending 1947-48 were inconstant. Both last year and the present year however green manure (G.M.) with sunnhemp (Crotalaria juncea) gave significantly higher yields than other treatments.

Treatment	Ave. grain yield in mds. acre	
	1948-49	1949-50
G. M. with sunnhemp at 40 lbs. N/acre	24·3	25·42
,, ,, cowpeas ,, ...	22·7	20·21
Mustard cake .. ,, ...	22·7	17·41
Castor cake .. ,, ...	20·2	15·99
F.Y.M. .. .. ,, ...	18·7	14·20
Compost .. ,, ...	23·1	14·47
Ammonium sulphate ,, ...	23·2	17·41
No manure (control) ,, ...	20·9	13·93
C.D. at 5% .. ,, ...	2·76	3·55

The experimental results over the entire period are being collated and a final report written up.

(*ix*) *Effect of N.P.K. & Ca in different levels and their combinations on wheat* : This experiment was started in 1945.

The results of the 1949-50 crop are given as under :—

Nitrogen lbs. per acre	Mean yield mds./ acre	P_2O_5 lbs./ acre.	Mean yield mds./ acre	K_2O lbs./ acre	Mean yield mds./ acre	Lime mds./ acre	Mean yield mds./ acre
0	20·2	0	22·3	0	22·5	0	23·1
20	21·4	80	23·3	80	22·4	5	21·9
40	25·4	160	21·4	160	22·4	10	22·0
C.D. at 5% ..	1·96						
$\overline{N_{40}}$ $\overline{N_{20}}$	No.						

For the third year nitrogen indicated significant response. Application of 40 lbs. N/acre significantly enhanced the yield over control or 20 lbs. N/acre. Other fertilizers did not show any effect. The interactions were also not significant.

(*x*) *Building up soil fertility through organic manures and inorganic fertilizers with and without legumes in rotation* : This experiment which was started in 1946-47 with the following rotations : *wheat-maize-wheat maize* and *wheat-maize-peas-maize* is now in its second cycle. The manuring is done to *rabi* crops. The comparative yield of wheat and peas during the year were as under :—

Treatment per acre	Yield of wheat C228 Mds/acre	Yield of peas NP29 Mds/acre
A. No. manure	7·4	6·3
B. Ammonium sulphate (60 lbs. N) *plus* super (100 lbs. P_2O_5) *plus* potassium sulphate (100 lbs. K_2O)	14·9	7·6
C. F.Y.M. (60 lbs. N) *plus* Super (100 lbs. P_2O_5) *plus* Potassium sulphate (100 lbs. K_2O)	10·0	7·3
D. Castor cake (60 lbs. N) *plus* Super (100 lbs. P_2O_5) *plus* Potassium sulphate (100 lbs. K_2O)	12·4	7·6
Mean	11·2	7·2
C.D. at 5%	1·89	0·73

In the case of wheat the response to application of nitrogen as ammonium sulphate and castor cake was more pronounced than that with farmyard manure. This is in conformity with results reported in 1948-49. Rotation with the legume gave higher yield than without it in the first cycle.

(*xi*) *Plant composition as an index of fertilizer requirement.* This experiment has been started with maize in 1949. The treatments were 0, 40, 80 lbs. nitrogen/acre applied as sulphate of ammonia ; O, 40, 80, lbs. P_2O_5/ acre applied as superphosphate and O, 60 lbs. K_2O/acre applied as potassium sulphate. In yield of maize grain the effects due to nitrogen only were significant at 5% level.

N_{80}	N_{40}	N_0		
31·85	31·78	26·17	C.D. at 5%	4·26

The experiment gave a very good yield of maize, the highest with N_{80} P_{80} K_0 was 35·27 mds/acre. The leaf samples collected at three different stages of growth are under analysis.

(*xii*) *Phosphate manures* : *Phosphatic manuring of berseem* : The efficiency of phosphates in increasing the yield of berseem fodder is now proved. The object of this experiment was to test the comparative response of different forms of available commercial phosphates. Out of ten different forms of phosphates each applied at the rate of 80 lbs. P_2O_5/acre, ammophos proved to be the best. This is corroborated also by another experiment in which three different forms of phosphates including ammophos were used.

(*xiii*) *Phosphatic manuring of berseem—effect of boron and molybdenum singly and in combination on berseem* : The object of this experiment was to assess the effect of boron and molybdenum singly and in combination on the fodder and seed yield of phosphate manured berseem as also to see how far the soil fertility can be built up under these conditions. The main plot treatments were superphosphate at 80 lbs.

P_2O_5 per acre, rock phosphate ground to pass 80 mesh sieve at 80 lbs P_2O_5/acre ammophos at 80 lbs P_2O_5/acre and ammonium sulphate to supply that quantity of nitrogen as supplied by ammophos. The sub-plot treatments were molybdenum at 1 lb. MoO_3/acre and boron at 5 lbs. borax/acre and boron *plus* molybdenum at the above doses. It was found that major phosphatic and ammonium sulphate treatments are significant at 1% level in the first three cuttings and the micronutrient elements are not significant. In the fourth cutting, however, it is the micronutrients that are significant at 5% and the major treatments are not significant. In the hay and seed yield also the micronutrient elements are significant at 1%.

(*xiv*) *Building up soil fertility by phosphate manuring of berseem with guar in rotation* :

The experiment was started in 1946-47. The cropping scheme is *Berseem-Gaur Berseem-Guar-Berseem-Gaur-Wheat-Wheat-Wheat.* Berseem in all the three years had been differentially manured. *Guar* in all three seasons failed due to water-logging. The results of the first crop of wheat obtained during the year are given below :—

Treatment to Berseem	Mean yield of wheat mds/ acre
A. No manure	21·1
B. Super at 50 lbs. P_2O_5/acre	21·6
C. Super at 100 lbs. P_2O_5/acre	17·7
D. Super at 50 lbs. P_2O_5/acre *plus* Potassium sulphate at 80 lbs K_2O/acre	20·5
E. Super at 100 lbs. P_2O_5/acre *plus* pot. sulph. at 80 lbs. K_2O/acre	18·26
'F' test	Not significant

Residual effect was not indicated. Phosphate response has been indicated in the first three crops of berseem.

(*xv*) *Direct and indirect manuring of cereals in rotation with rabi legumes* : This work was started in 1946-47 to compare the after-effects of phosphate manured berseem, *senji*, *methra*, gram and peas with direct manuring of maize and wheat. The results obtained in the first cycle showed that there was practically no difference between the after effects of phosphate manured legumes and the direct manuring of maize ; the wheat yields showed direct manuring to be better than the residual effect. The results obtained in the second cycle of the experiment show that PK treatment in the case of peas, *senji* and *methra* has given highest yields followed closely by P treatment. In the case of berseem NPK has given the best yield. In regard to the residual effect on maize and wheat the results this year are in some cases conflicting. A general conclusion that can be drawn is that the residual effect of *rabi* legumes is quite effective in the case of first crop following (e.g. maize) but when a second crop is followed after maize the fertility is not maintained and addition of nitrogen is beneficial.

Cultural experiments : (*xvi*) *Effect of seed rate on wheat yield* : During the year under report the experiment was carried out with NP 165 and C 518 under irrigated and with NP 4 under rainfed conditions. The seed rates used were 50, 65, 80, 95 and 110 lbs./acre. The results obtained were as under :—

Seed rate	Yield in Mds/acre.		
	N.P. 165	C. 518	N.P.4
A. 50 lbs.	16·10	17·55	22·73
B. 65 lbs.	16·20	18·90	24·73
C. 80 lbs.	17·45	22·57	25·75
D. 95 lbs.	16·75	17·00	22·84
E. 110 lbs.	17·10	18·90	23·47
C.D. at 5 %	1·19	4·13	1·20

It appeared that the optimum seed rate is 80 lbs/acre. Last year the results were also similar, there being no difference between 65, 80 and 95 lbs. though they were all better than 50 lbs.

(*xvii*) *Cultural experiment on gram.* The object was to see the effect of dates of sowing, spacing between lines and dates of sowing on the yield of gram. The results given below show that there was no significant difference between different dates of sowing though the crop sown on 30th October had given the highest yield. 10″ spacing and 5″ depth of sowing were significantly superior to other treatments.

Treatment	Yield in mds./acre	C.D. at 5%
Date of sowing 30th Oct.	19·14	
,, ,, 13th Nov.	15·44	
,, ,, 27th Nov.	17·25	
Spacing 10″ between lines	22·00	
,, 15″ ,, lines	19·86	2·93
,, 20″ ,, lines	15·61	
Depth of sowing 2½″ deep	18·45	
,, ,, 5″ deep	19·89	0·075

(*xviii*) *Multiple factor experiment on potato*: This experiment was started in 1947-48 with the object of studying the effect of different doses of K_2O (with NP constant) × seed size × spacing on the yeild and grade of potatoes (variety *Phulwa*). The results are given below :

Treatment	Yield in mds./acre
Size S_0=¾″—1″ diameter	195·12
S_1=1″—1¼″ diameter	221·58
S_2 1¼″—1½″ diameter	223·27
Spacing d_0=6″ between tubers	220·81
d_1=9″ between tubers	232·99
d_2=12″ between tubers	196·17
N P_2O_5 K_2O	
Manures K_0=80+60+0	215·84
K_1+80+60+40	211·29
K_2+80+60+80	222·84

The medium and big sized seeds are significantly superior to small sized seeds but there is no difference between the medium and big sized seeds showing medium sized seed to be the best. 9″ spacing between tubers is the optimum. Potash failed to show any effect.

(*xix*) *Weedicide experiment on wheat* : One spraying with "Methoxone" a proprietary weedicide preparation was compared to hand weeding and no weeding. Hand-weeding gave higher outturn per acre. In the pevious year also hand weeding gave better yields than spraying with methoxone.

Treatment	Mean yield in Mds./acre
No weeding (control)	14·6
Hand weeding—once	16·1
Methoxone @ 1 lb. /acre—once	15·0
C.D. at 5%	1·34

(*xx*) *Maximised production* :

Attempts were made to get the maximum yield of wheat, potatoes and gram under Delhi conditions. The results are shown below :

Crop	Variety	Area acres	Manurial treatment.	Yield in mds. per acre
Wheat	C. 518	2·5	20 lbs. N per acre and 25 lbs. P_2O_5 as ammophos broadcast at the time of first irrigation.	41·9
Potatoes	*Phulwa*	0·4	500 mds. of F.Y.M. as basal dose plus 100 lbs. ammonium sulphate broadcast at the time of planting plus 20 lbs. ammophos as top dressing after plants are 6″ high.	373
Gram	N P. 58	2·0	Ammophos at 40 lbs. P_2O_5 per acre and 32 lbs. N per acre.	14·8

Agrostology :

(*xxi*) *The establishment and testing of grasses and legumes in the nursery* :

The collection of grasses, both indigenous and exotic were further augmented by 2 exotic species thus making up 52 indigenous and 22 exotic species. The legume collection under observation was 49 species consisting of 20 indigenous and 29 exotic species. Amongst collection of *Kharif* legumes the following perennial legumes showed promise :

Centrosema pubescens, *Dolichos sp.*, *Desmodium cephalotes* and *Glycine javanica*. The following material from winter collection showed promise and have been selected for multiplication : *Vicia sativa* and *V. ervilia* from Cyprus, *V. benghalensis* and *V. naturalizada* from Uruguay, *Lathyrus sativa* and *Trigonella foenum—graecum* from Egypt, *Medicago hispida* from U.S.A. and *Medicago sativa* from Cyprus. Seeds of a number of grasses and legumes have been obtained and it is expected to make further additions in the collection.

(*xxii*) *Root studies of grasses* : In the building up of soil structue, the root system of grasses play an important role. A beginning was made this year with six-selected perennial indigenous grasses, with a view to obaining quantitative and qualitative data on thier root systems. This year all grasses showed a depth of about 2 feet nine weeks after sowing. The maximum depth, length and number of laterals was shown by *Dicanthium annulatum*. The maximum dry weight from 1 cubic foot of soil was shown by the root system of *Cenchrus setigerus*.

(*xxiii*) *Improvement of paddocks* : A grazing experiment has been started at Karnal this season to compare the effects of the deferred grazing and controlled continuous grazing on the productivity and upon the health of the grazing stock. One to three year's heifers at the rate of three animals per acre was given. The results are given below :

Paddock No.	Area	Grazing treatmeant	Initial wt. in lbs.	Final wt. in lbs.	Total gains in lbs.	Gain per head	Gain per head daily	Gain per 100 lbs. live wt	No. of days grazed	No. of animals
1	1·8	Continuous grazing.	2460	2606	146	29·2	0·28	5·9	105	5
II, III & IV.	10·5	Deferred grazing	14098	15390	1292	40·4	0·38	9·2	105	32

The data showed that under a system of deferred grazing the animals gave very high individual gains of 40·4 lbs. as against 29·2 lbs. obtaining under continuous grazing, the grazing period being 105 days in each case.

(*xxiv*) *Seed mixture trial* : An experiment to evaluate the total yield of fodder and protein in mds. grasses per acre from oats and *Phalaris minor* in combination with three seed rates of legumes : *senji* (*Melilotus parviflora*) and Vicia (*Vicia hirsuta*) has been in progress. Results showed that (1) Oats in mixture gave less yield than when grown alone while the mixture of *Phalaris* with *senji* gave a higher yield than *Phalaris* alone or in combination with Vicia. (2) Oats and its mixture were superior to *Phalaris* alone or its combination, both in fodder yield and protein output. (3) *Senji*-grass combination is better than *Vicia*-grass combination (4) grasses grown in association with legumes showed a higher protein content than when grown alone. The protein content generally increased with increasing legume rate.

(*xxv*) *Cultural experiment on Phalaris minor* : An experiment to study the effect of seed rate and method of sowing and cutting under irrigated and unirrigated conditions on the yield of *Phalaris minor* showed that (i) seed rate of 8 lbs. per acre gave significantly higher yields than 6 lbs. or 4 lbs., there being no difference between the latter two, (ii) under irrigation 2 cuttings were possible which gave significantly higher yields than where only one cut was taken and (*iii*) there is no significant difference between the methods of sowing.

(*xxvi*) *Studies on Kudzu vine* : The observation that Kudzu vine flowered in September, 1948 and again in May, 1949 has been confirmed this year and it is concluded that the vine flowers twice a year normally after 3 years of growth. The pod formation, scanty last year, improved, and a stock material of 325 seeds was obtained. Germination tests with these seeds indicated that mechanical scarification of seeds before sowing was necessary for successful germination. The agronomic scheme financed by Indian Council of Agricultural Research for investigating factors responsible for flower and pod formation in Kudzu vine as also trials of indigenous species of *Pueraria* species is being worked out. So far only three species of *Pueraria*, namely *P. tubcrosa*, *P. phaseoloides* and *P. hirsuta* (Kudzu vine) have been collected and established. *P. tuberosa* showed a very vigorous growth like Kudzu vine and had broader leaves. No flowering was observed due to the effect of various treatments given to established Kudzu plants.

COLLABORATIVE EXPERIMENTS WITH THE STATES

1. A collaborative trial with promising grasses and legumes was sponsored during 1949-50 in co-operation with different States. The object of these trials was to study their performances under different climatic and soil conditions. 13 States are participating in the trial : (1) East Punjab, (2) Assam, (3) Rajasthan, (4) Cochin, (5) Himachal Pradesh, (6) West Bengal, (7) Uttar Pradesh, (8) Bihar, (9) Bombay, (10) Madras, (11) Madhya-Pradesh, (12) Saurashtra, and (13) Ajmer-Merwara.

2. Arrangements have been made for collaborative experiments to test (1) the comparative value of magnesium ammonium phosphate on paddy under acid soil conditions in the following States : Assam, Bihar, Madras and West Bengal and (2) relative value of sodium nitrate and ammonium chloride on paddy, wheat, sugarcane, cotton, tea and jute, in different States.

CATTLE BREEDING AND MANAGEMENT

The strength of the Sahiwal herd has increased considerably over the scheduled strength, the selling of surplus stock having been very low. The herd suffered from the after-effect of foot and mouth disease which occurred in the latter part of the previous year. This was further aggravated by the 'three days fever', almost an epidemic in the young stock. There were also a few cases of mineral deficiency of cows after freshening. There were also four cases of death in cows due to Johne's disease. The work on the line breeding and selection for improving dairy qualities and precalving milking to induce an early flush and docile temperament were continued.

Calf rearing : 47 female and 56 male calves were born of which 8 died giving mortality of 7·5% . Out of these 8 deaths, 5 died of foot and mouth disease.

Early Maturity : 25 heifers matured to cows at an average age of 2 years 7 months and 10 days.

Milk yield : 26 heifers closed their lactation during the year of which 10 have yielded more than six thousand pounds of milk in 10 months lactation. The average lactation yield was 5449 lbs. in an average period of 290 days. Heifers Paprokee and Abafjai have yielded 8006 and 9181 lbs. respectively. Ten adult cows completing their lactation during the year yielded over eight thousand pounds of milk in 306 days. The cow Tamili has yielded 12,768 lbs. in her 7th lactation. She had yielded 13,008 lbs. in her previous lactation. The average lactation yield of the adult cows was 7664 lbs. with a dry period of 122 days.

Programme of Work for 1950-51.

1. *Soil fertility problems* :

(a) *Manurial experiments on cereals and crops in rotation.*

(i) *Nitrogenous manures and fertilizers* :—Experiments to test the relative values of nitrogen in organic and inorganic manures and also responses of their combination on wheat, maize and paddy.

(ii) *Phosphatic fertilizers* :—Experiments with the different forms of phosphatic fertilizers to study their responses on *Kharif* and *Rabi* legumes and after effects on cereals following the legumes.

(iii) *Nitrogenous and phosphatic fertilizers* :—Experiments to study the effect of these each at different levels and in combinations on the yield of wheat.

(iv) *Green manures* :—Experiments with different legumes as green manures with and without fertilizers on wheat. Experiments to study the effect of green manuring when the crop is grown *in situ* and brought from outside.

(v) *Manurial and cultural experiment on sugarcane.*

(vi) *Permanent Manurial and New Manurial experiments of Pusa.*

(vii) (*a*) *Micronutrient studies on berseem-guar-berseem-maize-wheat-rotation.*

(b) *Placement of fertilizers in row crops* :—To effect economy in the quantity of fertilizers used and their better utilization by field crops.

(c) *Mixed Cropping of Cereals and legumes* :—To study the possibility of maintaining soil fertility by growing a mixture of cereals and legumes under different fertilizer treatments.

(d) *Mixed farming* :—To obtain maximum overall yields which a cultivator is likely to get from holdings of 6 acres under irrigated conditions designed to meet the requirements of his family members and cattle and produce milk for cash sale.

2. *Irrigation experiments* :—To study the irrigation interval effect on various crops.

3. *Cultural experiments* :—Planting distance of potatoes, depth of sowing gram, different preparatory tillage treatments on sugarcane, spacing in maize and cotton, tillage experiments on wheat and maize.

4. *Varietal yield trials* :—Experiments will be conducted with improved varieties of different crops such as sugarcane, wheat, tobacco, potatoes, sweet potatoes, tomatoes, coton and maize hybrids.

5 *Agrostology* : To produce high yielding and palatable fodder grasses and legumes for cattle, increase the productivity of natural grasslands ; to work out suitable seed mixtures of grasses and legumes for pasture, to evolve a suitable system of ley farming ; Maintenance of nursery.

CATTLE BREEDING AND MANAGEMENT

1. Line breeding and selection for improvement of milk yield.

2. Handling of the stock for the development of milk temperament.

3 Feeding of stock on balanced rations for growth, early maturity and high milk production.

4 Four times milking as a means of stimulation for the production of high yield.

5. Pre-milking as a means of stimulation for milk production, to train heifers to milk before calving and to prevent udder trouble.

6 Calf rearing on standardised milk ration containing 3·5 percent butter fat.

7 Early maturity treatments to test bulls for their transmitting capacity of high milk yield quality at an early age.

AGRICULTURAL RESEARCH SUBSTATION, KARNAL

Annual Report for the year 1949-50.

General :

The total area of the Substation is 2,154 acres, out of which 285·5 acres remained with the Punjab Government. The area cropped in the *kharif* and *rabi* seasons were 632 and 519 acres respectively. In addition to this, 270 acres were cultivated on share system (*batai*) in the *rabi*.

The main activities of the Substation were to (*i*) carry out large scale field experiments on different aspects of agronomic research, (*ii*) multiply and distribute seeds of improved strains of field crops, (*iii*) improve the milch and draught qualities of the Tharparkar breed (dual purpose cattle) by line breeding and judicious management and (*iv*) render assistance to the different Divisions of the Institute in carrying out their field experiments.

Out of three tubewells sanctioned by the Government of India for irrigation purposes, one was sunk in November, 1948, but could not be worked as the pumps were not installed. The position of tractors and tractor implements remained unsatisfactory.

Crop Section

Response of crops to season :

The total rainfall from 1st June 1949 to 31st May 1950 amounted to 27·25 inches as against 31·44 and 39·86 inches recorded during the corresponding periods in 1948-49 and 1947-48 respectively. The abnormally high rainfall of 14·45 inches in July led to the late sowing of *kharif* crops, except paddy, and thus lowered the yields of the former crops to some extent. The *rabi* season was favourable for the growth of all crops, except gram, which suffered due to wilt in many plots.

The yields of principal crops grown on the farm are given as below :—

Yields of principal crops grown in the year 1949-50.

Crop	Area (Acres)	Average yield per acre (mds.)	Remarks
Paddy	64·43	22·01	
Maize	28·56	7·09	
Jowar	33·50	2·06	
Guar	24·50	7·72	
Wheat	70·34	14·80	
Oats	134·04	10·85	
Barley	24·42	15·17	
Gram	90·53	9·38	
Pea	15·28	7·97	
Berseem	2·00	3·70	Threshing of seed from 8 acres is in progress
Jowar (Green fodder)	111·29	109·56	
Cowpea (Green fodder)	27·50	79·38	
Berseem (Green fodder)	38·30	728·25	

Research Projects

Manurial experiments :—

Effect of bonemeal, farmyard manure and ammonium sulphate on paddy and after-effects on berseem :—The experiment was in progress. The results were not conclusive as the differences among the treatments were not significant.

Direct manuring of paddy with ammonium sulphate and indirect manuring wit farmyard manure and bonemeal :—The application of bonemeal at 120 lbs. P_2O_5 farmyard manure at 40 lbs. N and farmyard manure at 40 lbs. N in combination with bonemeal at 80 lbs. P_2O_5 per acre gave better yields of berseem as well as the following yields of paddy than the other treatments. In the case of paddy the differences were significant.

Direct and indirect manuring of paddy in rotation with rabi legumes :—These experiments were concluded after three years. Among the various legumes grown in rotation with pady, berseem, shaftal, gram and peas responded to the direct manuring with NPK, though not significantly. The after effects on paddy were less marked than the effect of direct manuring of paddy with NPK or nitrogen.

Paddy manurial experiments-paddy-wheat and paddy-fallow rotations :—These experiments were concluded after being run for three years. The fertilizer treatments given to both paddy and wheat were N, P, K, NP, NK, PK and NPK. The results were not significant in the case of paddy-wheat rotation, while in the paddy-fallow rotations, the NPK, NK and N treatments showed better response than the other treatmens.

Direct and indirect manuring of berseem and paddy :—An elaborate experiment was laid down last year to study the effect of N and P_2O_5, each at three levels and their combinations on berseems and paddy. The experiment is in progress.

Paddy seedling dipping experiment :—This experiment, started in 1945-46, was concluded during the year under report. The treatments consisted of dipping the seedlings in a mixture of (*i*) night-soil, earth and wood-ash, (*ii*) F.Y.M., earth and wood ash and (*iii*) NPK. Though the results have not shown significant differences, the treatment with night soil gave slightly increased yield over the other treatments.

Paddy nursery manurial experiment :—The object of this experiment is to study the effect of manures and fertilizers when applied to the nursery and to see how far the vigour and extra growth induced by manuring in the nursery are reflected on the final yield of paddy without further treatment after transplanting. The treatments comprised three forms of nitrogenous manures applied at four levels in combination with three levels of P_2O_5. Like last year, the application of nitrogen at 200 lbs. per acre gave significant increases over other doses. The yields of paddy in maunds per acre obtained during the year with different doses of ammonium sulphate were as follows :—No manure—23·8 ; 100 lbs. N—26.5 ; 200 lbs. N—30·6 ; 400 lbs. N—24·2

Green manuring of wheat in conjunction with fertilizers :—In this experiment, four green manuring crops, *viz.*, sannhemp, cowpea, *guar* and *moth* have been included. They were manured with phosphate at sowing, while the subsequent crop of wheat was manured with N, K and NK. Cowpea and sannhemp were found significantly superior to *moth* and "no green manure" treatments. Among the fertilizer treatments, N, NP, NK and NPK (P applied to the green crop) gave significantly better results than the other treatments. It was found that phosphate alone, applied to the green manure crop, was not as effective as nitrogen applied to the wheat crop or nitrogen in conjunction with phosphate to the green manure crops or nitrogen with potash applied to the wheat crop or nitrogen and potash applied to the wheat crop in conjunction with phosphate to the green manure crops. The average yields of wheat C. 518 in maunds per acre due to various treatments were as follows :—Sunnhemp G.M.—25·4, Cowpea G.M.—25·9 ; *Guar* G.M.—22·7 ; *Moth* G.M.—19·5 and No G.M.—20·5 ; N—27·4, P—19·3, K—19·4, NP—27·1, NK—26·2, PK—19·0, NPK—26·0 and no manure —18·1. The interaction between green manuring treatments and fertilizer treatments was significant.

Green manuring in conjunction with phosphate applied at different intervals :—The object of this experiment is to study the effect of green manuring in conjunction with superphosphate (at 80 lbs. P_2O_5 per acre) applied at the time of sowing and burying sunnhemp and at the time of sowing wheat, on the yield of wheat. From the yields of wheat N.P. 4 obtained, it was found that the effects of phosphate, whether applied to the green manuring crop at sowing (30·7 maunds per acre) or burying (29·4 maunds per acre) or to the wheat crop after green manuring (28·3 maunds per acre), were equally good and better than no green manuring (21·9 maunds per acre) or green manuring without phosphate (25·4 mards per acre). The highest yield was, however, obtained when phosphate was applied at the time of sowing the green manuring crop.

Green manuring with kharif legumes :—This experiment was started to study the comparative values of the different *kharif* legumes as green manure crops. The succeeding crop was wheat N.P. 710. Though the differences among the legumes were not significant, cowpea, *guar* and *mung* showed encouraging results.

Varietal trials :

Jowar varietal trial :—Five varieties of *jowar* were tested for their yield of seed. Differences among the varieties were not significant.

Wheat varietal trial :—Twelve N.P. varieties of 700 series together with Punjab C.518 and C.591 were included in a trial to test their yields. The results were found to be significant. Variety C. 518 gave the highest yield (22·9 maunds per acre) and this was followed by N.P. 775 (22 maunds per acre), C.591 (21·8 maunds per acre), N.P. 710 (19·9 maunds per acre) and N.P. 760 (19 maunds per acre). The differences among these varieties were not significant. N.P. 775 was found to be significantly superior to N.P. 715, N.P. 762, N.P. 737, N.P. 745, N.P. 758 and N.P. 764. C.518 was badly affected by black rust and N.P. 744 and N.P. 762 by yellow rust.

Potato varietal trial :—Four hybrids of potato, *viz.*, 291, 208, 209 and 610 were tested against the local variety of Phulwa. Hybrid 209 gave the highest yield of 252 maunds per acre and was significantly superior to all others, except Hybrid 208, which yielded 228 maunds per acre. Hybrid 291 was found to be most susceptible to virus disease.

Cultural experiments :

Paddy cultivation experiment :—The object of this experiment is to make a comparative study of the effect of tractor ploughing and bullock ploughing given (*i*) after the harvest of paddy and (*ii*) at the normal time, *i.e.* before transplanting, on the yield of paddy. The results obtained during the year under report were not significant ; the tractor ploughing indicate a slight increase (20·3 maunds per acre) over the bullock ploughing (18·0 maunds per acre). The highest yield was got from plots ploughed with tractor at the normal time (21·2 maunds per acre).

Fertilizer placement experiment on guar and residual effect on wheat :—*Guar* was sown with placed and broadcast fertilizers *viz.*, P, NP and NPK to see whether placed fertilizers would give better yields of the legume and build up soil fertility for the succeeding crop of wheat. The results were not significant.

Tillage of wheat in conjunction with manuring with F.Y.M. and ammonium sulphate :—Seed bed preparations were done by (*i*) tractor plough, (*ii*) bullock drawn inversion *cum* non-inversion ploughs and (*iii*) bullock-drawn non-inversion plough. The differences in the yield of wheat due of these treatments were not significant. The manurial treatments consisted of (*i*) ammonium sulphate 60 lbs. N, (*ii*) F.Y.M. 60 lbs. N and (*iii*) F.Y.M. plus ammonium sulphate to supply 30 lbs. N each. The interaction between cultural operations and manurial treatments was not significant. The treatment with ammonium sulphate gave the highest yield of 13·5 maunds per acre and was significant over the ' no manure ' and F.Y.M. treatments.

Tillage of wheat in conjunction with green manuring and application of fertilizers :—The cultural treatments in this experiment were (*i*) tractor ploughing and (*ii*) bullock-drawn inversion *cum* non-inversion ploughing. The whole area was green manured in the *kharif* with sunnhemp and the following fertilizer treatments were given :—(*i*) P at sowing sunnhemp, (*ii*) PK at sowing sunnhemp, (*iii*) N to wheat, (*iv*) NP to wheat and (*v*) NPK to wheat. The yields of wheat N. P. 165 due to tractor ploughing and bullock ploughing were 22·0 and 19·4 maunds per acre respectively and the differences were not significant. Among the fertilizers treatments, those applied to wheat, *i.e.*, N, NP and NPK were significant over those applied to the green manure crop, *i.e.* P and PK. The respective yields were 25·4, 25·4, 24·9, 15·7 and 16·5 maunds and that of control was 16·3 maunds per acre. It will be seen that these results confirm those reported earlier under " Green manuring of wheat in conjunction with fertilizers ". In regard to interactions, it was found, that

P or PK in conjunction with green manure and tractor ploughing gave significantly higher yields (20·4 and 21·5 maunds per acre) than those with bullock ploughing (10·9 and 11·5 maunds per acre).

Gram cultural experiment for the control of wilt :—Gram was sown after *jowar* on three dates (Oct. 27, Nov. 10 and Nov. 24) at two depths (2½″ and 5″) and three spacings (10″, 15″ and 20″) to study whether such treatments would affect the incidence of wilt in gram N.P. 58. The incidence of wilt in the plot under this experiment was negligible during the year under report, and therefore, no definite conclusions could be drawn. As regards yield of gram, though the main effects were not significant, early and deep sowing with narrow spacing gave comparatively better yields. The interaction between dates of sowing and depth was significant. First date of sowing with 2½″ depth gave better yields (10·2 maunds per acre) than 5″ depth (7·1 maunds per acre). In the second and third sowings, 5″ depth gave better results (11·1 and 5·0 maunds per acre) than 2½″ depth (5·8 and 3·1 maunds per acre). It is obvious that the moisture status was better in the deeper layer at the second and third dates, and therefore better germination was secured in these plots than those sown at 2½″ depth.

Mixed farming and cultivators' holdings :—

Long term experiments were in progress with eight holdings of varying sizes ranging from 400 acres to 6 acres to study how far they are self-sufficient in providing the requirements of different numbers of human beings and cattle, depending on the size of the holding. All these holdings, except the 400 acre unit, were worked by bullock power, while the former was culivated partially by tractors. No definite conclusions have yet been drawn from the experiments.

Miscellaneous experiments :—

Effect of ' Alphatron ' on paddy :—A pot culture experiment was conducted to study the effect of ' Alphatron ', a radio-active substance, on the growth and yield of paddy, N.P. 125. From growth observations such as height, number of tillers and leaves, it was found that ' Alphatron ' alone showed very little superiority over the ' no manure ' treatment. The NPK treatment showed the best results. Similar results were found with grain and straw yields ; NPK gave significantly better results, than NPK plus ' Alphatron ', ' Alphatron ' alone and ' no manure ' treatment.

Seed supply :

The following quantities of seeds of improved varieties of crops were distributed during the year under report :—

Crop	Quantity
	Mds.
Wheat	184·8
Paddy	43·4
Oats	4·00
Gram	0·14
Peas	2·6
Cowpeas	17·50
Jowar	16·20
Cotton	0·38
Anjan grass	0·40
Berseem	0·85
Sugarcane (setts)	3,192·58
Total ..	3,462·98

Cattle Breeding Section

General:—The strength of the herd at the close of the year was 385 head comprising of 94 cows, 12 bulls, 91 young female stock, 100 young male stock and 88 young calves. This represents an increase of 60 per cent over the normal strength of 240 head. The animals in general maintained good health. They were protected against Rinderpest. Black Quarters and Haemorrhagic Septicaemia by preventive inocculations. Foot and mouth disease appeared in herd during the last week of April, 1950. Out of 122 animals affected, there were six cases of mortality among the calves.

Milk yield:—The wet and overall averages recorded during the year were 20·2 lbs. and 10·7 lbs. per cow per day respectively as against 18·6 and 12·0 lbs. recorded last year. The fall in the overall average was due to the sale of 40 cows to the Rehabilitation Colony, Nilokheri, out of which 23 were in milk. Out of 52 cows and 27 heifers which completed their lactations during the year under report, 2 did over 9,000 lbs., 4 over 8,000 lbs., 11 over 7,000 lbs. and 5 over 6,000 lbs. of milk in a lactation period of 306 days.

Calf rearing:—56 female calves with an average birth weight of 49 lbs. and 48 male calves with an average birth weight of 52 lbs. were born. They were weaned at birth and reared by pail-feeding. The rate of growth is indicated below :

Rate of growth in lbs. per day

	Upto 3 months		Upto 6 months		Upto 9 months	
	1948-49	1949-50	1948-49	1949-50	1948-49	1949-50
Male	0·88	1·3	0·77	1·3	1·3	1·0
Female	0·83	1·2	0·88	1·0	0·78	1·0

The mortality was 15·4 per cent as against 10·7 per cent recorded last year. There were six deaths due to foot and mouth disease.

Sale of Cattle:—During the year under report, 35 animals were sold to the West Bengal Government, 23 to Uttar Pradesh, 44 to the Rehabilitation Colony, Nilokheri and 10 by public auction.

Programme of work for 1950-51

Work will be continued on the lines mentioned in the report. The following new items will also be included.

A. *Crop Section* :

1. Agrobiological studies on paddy.
2. Chilli manurial experiment.
3. Varietal trials with tomato, chilli, brinjal, cotton, sweet potato and linseed.
4. FAO maize hybrid trial.
5. Australian and Canadian maize hybrid trial.
6. Commercial maize hybrid trial.

7. Paddy cultural experiment involving dates of transplanting, spacing, number of seedling per hole and varieties.

8. Testing of promising grasses and legumes for fodder.

B. *Cattle Breeding Section* :

1. Experiment on three and four times milking.

2. Control of ticks (external parisites of animals) with different chemical agents.

DIVISION OF BOTANY

Annual Report for the Year 1949-50

The chief aim of the researches carried out in this Division is to test and devise methods for evolving superior crop varieties. Basic problems of all-India importance, e.g., breeding for hardiness, disease resistance and adaptability to different soils and climates, receive special emphasis and to this end the Division does collaborative work with the different States of India and with international organizations. Fundamental researches in cognate sciences, like plant genetics, cytology, physiology and systematic botany, are undertaken for integrating such knowledge for use in the methods and techniques for efficient plant breeding.

Plant Breeding and Genetics

Breeding for rust resistance in wheat :

The object of this work, which was being done at Simla under a scheme financed by the Indian Council of Agricultural Research and with the cooperation of the late Dr. K. C. Mehta of Agra University, is to evolve for the hills high-yielding wheats resistant to rusts. The rusts oversummer in the hills and these regions therefore constitute foci of infection for the wheat crop in the plains.

Four hundred and ninety one cultures comprising previous selections, exotic material and hybrid progenies—including a number of interspecific and intergeneric hybrids—were tested under artificial inoculation with a mixture of all the three rusts, as well as under natural incidence of the disease. A number of resistant promising selections have been made. Good yielding rust-resistant selections have also been made at Delhi.

Wheat varietal trials :

(*a*) *New N.P. Wheats* :—Twelve among the newly-evolved N.P. wheats were under trial for the third year to ascertain their suitability to different soil and climatic conditions. This year the trials were conducted, with the cooperation of the State departments of Agriculture, at 28 different stations representing the important wheat-growing tracts of India. Some of these varieties have done very well in a number of places both with regard to grain yield and rust resistance, thus confirming, in the main, the last two years' results. The promising varieties were East Punjab, Delhi, West U.P. and Rajputana—N.P. 710, 715, 718, 720, 737, 75[illegible] 775 ; Allahabad, Kanpur, Atarra—N.P. 710, 718, 720, 758, 762 ; U.P. and Bihar—N.P. 710, 720, 758, 760, 775 ; Bengal—N.P. 710, 760, 775 ; Madhya Pradesh and Madhya Bharat—N.P. 715, 720, 737, 758, 760, 762, 775 ; Hyderabad and Bombay—N.P. 715, 720, 760, 775.

(*b*) *Some exotic wheats* :—In a small scale trial for general performance and rust resistance conducted at Delhi with 11 exotic varieties from Australia, U.S.A., Kenya and Egypt and the local, N.P. 165, some of the varieties appeared promising.

(c) *Trials of some black rust resistant hybrids* :—A number of black-rust resistant hybrid strains, e.g., S. 126, M.H. 43, N.P. 721, and 710 and two selections from W. 245, evolved at Simla and Delhi, have given promising results in trials at Delhi as regards yield and rust resistance.

Varietal response of wheat varieties to manures :

This experiment, repeated for the third year, was carried out to determine the response of five varieties, viz., N.P. 165, 125, 710 and 761, Punjab C 518 and a mixture of them, to four levels of manuring. The results indicated that although there was differential varietal response to manurial doses, these differences were statistically insignificant. Unlike last year, however, the overall effect of varieties was statistically significant. The maximum manurial dose and the half-maximum dose showed no significant difference between them in their effect on varietal yields although they both did significantly better than 'only nitrogen' and the control. A combined statistical analysis of all the three years' results is being undertaken.

Description of wheat varieties for the World Catalogue of Genetic Stock :

Collaborative work with the F.A.O. has been undertaken for cataloguing of world genetic stocks in wheat for purposes of exchange of materials and information with various plant breeding institutions.

Breeding rust resistant linseed (*Linum usitatissimum*) :

Thirty-five strains resistant to linseed rust (*Melampsora lini*) under natural incidence of the disease in the field and under conditions of artificial inoculation (with the cooperation of Mycology Division) have been evolved at this Division. Some of these strains gave, this year again, higher yield of seeds containing distinctly higher oil-content as compared to the N.P. types. In a replicated trial at Delhi, 5 rust resistant strains outyielded all the N.P. types used as controls, and also the 3 exotic varieties, (Dakota, Shyenne and B 5128) obtained through the Indian Oilseeds Committee. Preliminary performance trials with 35 rust-resistant strains were conducted at 10 centres in 6 states; the strains have done very well, as compared to the local varieties, at a majority of the centres.

Genetical observations in varietal hybrids, studied under artificial inoculation with the rust, confirmed those of the foreign workers, that rust resistance was inherited on a monogenic basis, resistance being dominant over susceptibility. This character was inherited independently of petal colour and another colour.

Breeding wilt resistant pigeon pea (*Cajanus cajan* (*L.*) Millsp.) :

Under artificial tests of inoculation the high wilt resistance of N.P. 41 and of 9 newly evolved hybrid strains was confirmed; they are now ready for performance trials.

Breeding tomato varieties combining earliness, high vitamin content and improved flavour :

Six hybrid strains evolved from the cross *Lycopersicon esculentum* (cultivated tomato) $\times$*L. pimpinellifolium* (wild species) for early maturity, high vitamin C sugar content were under trial in and 2 centres in different states. Results, so far available only from Coimbatore, Lucknow and Jaipur have shown that at all these places the hybrids were 20-30 days earlier in maturity than the local varieties and some of them also outyielded the locals.

The following table gives some observations recorded on the hybrids and a few among the commercial varieties under trial at Delhi.

Material	Days from sowing to fruit ripening	Yield (lb) per 100 plants	Vitamin* C content (Mg/100 gm).	Total* sugars %
1. *New Selections*—				
Hybrid 1	95	190	52·7	2·81
Hybrid 2	118	220	52·5	4·48
Hybrid 3	96	350	45·0	..
Hybrid 4	102	400	38·9	4·63
Hybrid 5	121	200	38·1	..
Hybrid 6	112	260	57·0	4·69
Hybrid 8	101	280	58·6	3·37
Hybrid 9	112	250	50·3	3·80
2. *Commercial varieties*—				
Desi	129	400	39·0	2·30
Earliana	126	300	42·0	2·83
Red Cloud (U.S.A.)	138	350	28·3	2·54

* Analysis carried out in the Chemistry Division.

An unusually frost-free period, until mid-February, experienced this year enabled the commercial varieties to register high yields. Usually, they succumb to frost in late December and January ; the hybrids, being early, give their full yield before this.

Other wild tomato species, e.g., *L. peruvianum*, *L. hirsutum*, *L. glandulosum*, *L. pisissi*, were under study with a view to their possible utilization in breeding.

Hybrid Maize :

This work is being done under a scheme financed by the Indian Council of Agricultural Research. The material under study included 401 indigenous and 35 foreign open-pollinated varieties, 10 double crosses from Canada and Australia and 24 double crosses from U.S.A. received through the F.A.O. Promising among indigenous varieties were the Pusa selection 4, 5 and 14, Punjab 22, Rampur Swar White, Jaunpur White 2 and Kanpur T. 31. Of the foreign varieties, Belladi and Colorado Sel Castido did rather well. A few among the foreign hybrids, VL1, VL3, and VL5, obtained from Mr. B. Sen of Almora also did well. The 24 double crosses received through the F.A.O. were under trial at Delhi, Coimbatore, Kanpur and Nagpur ; trials at the latter two places suffered badly from very late sowing.

Both at Delhi and Coimbatore the following were among the high yielding double crosses :

Hybrid	Yield of grain (Md/acre) at	
	Delhi	Coimbatore
1. Indiana 251A	19·9	19·8
2. Ohio M34	17·1	17·4
3. Iowa Hybrid 4316	16·4	17·4
4. Ohio K35	16·7	16·9
5. U.S. Hybrid 13	14·6	17·8
6. Control*	8·8	15·6

*At Delhi, Pusa Yellow 2 ; At Coimbatore, Local variety.

Six hundred inbreds in different generations were under study with regard to their desirability in breeding. A number of selfed and sibbed lines were also grown for evaluating the comparative merits of the two methods in obtaining inbreds.

Thirty six American and 10 Australian and Canadian hybrids have been sent to 25 centres in the different states for trial during 1950-51.

Hybrid onion :

A start has been made towards breeding hybrid onions. About 50 indigenous and foreign varieties were under study to evaluate their usefulness for hybridisation.

Breeding tobacco (Nicotiana rustica) with high nicotine for commercial utilisation :

A number of selections, possessing high yield of leaf of good quality, size and shape and having high nicotine content, have been evolved at the Division. They were under performance trials in cooperation with the Divisions of Agronomy and Chemistry.

Some of these selections appeared very promising ; more important among the observations on them are tabulated below :

	N. P. 18 (Control)	S. 14	S. 19	S. 20	S. 22
Mean yield (Mds/acre)	13·0	19·2	19·1	21·3	18·9
Ratio of Leaf/Stem	5·4	7·8	9·6	9·1	8·6
Leaf yield (Mds/acre)	10·9	17·0	17·3	19·2	16·9
Nicotine content (percent)	1·56	1·53	1·90	2·60	1·81

Cytology and Cytogenetics

Crop improvement through induced autopolyploidy :

Colchicine-induced autotetraploids of some oleiferous brassicas, sesame, linseed, chilli and gram have been under study for some years past, with special reference to improvement in their seed fertility, and hence their yield, by single plant selection. While self-fertilized crops like chilli, gram and sesame have not responded to such selection over several years, it has been possible to greatly increase the seed-fertility in the case of toria (*Brassica campestris var. toria*), a cross fertilised crop, by selection. In the latter crop, *elite* bulk populations of promising polyploid selections are now being built up. One such population, grown this year alongside a diploid population and away from other polyploids, indicated in a small scale survey that the tetraploid population outyielded the diploid by about 10 per cent ; further work is needed to confirm this observation.

Tetraploidy has been induced in a number of distinct types among each of the above crops to evaluate the possibility of improving seed-fertility by interbreeding such types and to study the differences among the polyploids so obtained. Such differences were noticeable in gram. Some lines of autotetraploid linseed, were found to be not breeding true to chromosome number, like those of *Eruca sativa* reported last year. An embryological investigation was undertaken in linseed which would greatly help in understanding the problem of seed sterility in autopolyploids.

Breeding disease resistant sesame through interspecific hybridisation :

Work has been in progress for breeding types of sesame (*Sesamum orientale*, 2n=26) resistant to phyllody, a serious disease believed to be caused by a virus, by hybridizing the cultivated species with a hardy resistant wild species, *S. prostratum* (2n=32). A fertile amphidiploid was obtained by doubling the chromosomes of the sterile hybrid resulting from hybridising these. The amphidiploid was backcrossed to cultivated sesame (N. P. 6) and in the subsequent progenies, *orientale* like plants also containing either certain genes or whole chromosomes incorporated from the wild species, have been obtained ; some of them appeared to be free from phyllody under field conditions. The final selections, which have now been made, are ready for preliminary performance trials.

During the year, the amphidiploid was backcrossed to a number of other types of cultivated sesame to obtain a larger variability in the subsequent progenies for selection of agronomically desirable characters.

Cytogenetics of Triticum and allied genera :

Meiotic irregularities, mainly comprising small frequencies of univalent formation, were observed in three intervarietal hybrids in *T. vulgare*. Cytology of a few interspecific hybrids involving *T. timopheevi*, *T. turgidum*, *T. dicoccum* and *T. vulgare* was studied. Chromosome pairing during meiosis in F_1 (*T. timopheevi* × *T. turgidum*) was found to be incomplete and variable. This confirms the findings which led Kostoff to represent the genomes of the two species as Aβ and AB respectively ; the β genome in *T. timopheevi* arising from a partial modification of the B genome in *T. turgidum*.

Meiosis was also studied in a number of *Triticum—Agropyron* derivatives ; these were found to have variable chromosome numbers.

Crop Physiology

Study of drought resistance in wheat :

Experiments were undertaken with 11 varieties of wheat in pot and field culture. Intermittent drought was given in the pot experiment, by reducing the frequency of watering, throughout the life cycle and at two other stages, one commencing

a week after anthesis and the other from 4th February 1950 onwards. In the field experiments moisture content at various depths (at 1′ intervals upto 4′) was also determined from time to time in plots with and without irrigation. The moisture stress (a gradual decrease from moisture equivalent point) commenced from about the end of January in the field experiment. A close study of the data indicated that grain size (1,000 grain weight) and spikelet or grain number per ear very largely controlled yield under these conditions. Generally speaking, maximum tiller number was correlated with ear number and total number of spikelets with that of fertile ones per ear. The varietal difference as regards spikelet number and grain size persisted under different conditions (also seasons, as data from the past season show). It would seem worthwhile, therefore, to combine high spikelet number per ear with large grain size in those varieties in which ear number is high. From the information so far at hand N.P. 52 and C228 appear to be suitable parent materials for this purpose.

Physiological analysis of factors concerned with yield :

A detailed analysis of the relation between the increase in total dry matter of the plant (main shoot only), after anthesis, and grain formation in varieties N.P. 710, N.P. 52 and N.P. 165 was undertaken at two stages, one about 4 weeks after anthesis and the other at harvest. The results were in substantial agreement with those reported last year, the contribution by the ear to grain weight being the highest in N.P. 710 and the lowest in N.P. 165.

Detailed observations on the persistence of green colour in the leaves and ears indicated the following differences.

	N. P. 165	N. P. 710
No. of days ear remained green after anthesis	34	39
No. of days leaves remained green after anthesis	50	44

It is possible that this varietal difference may partly account for the relatively greater contribution of the ear in N.P. 710. It may, however, be noted that during the first 3 weeks after the experiment commenced, when no such difference existed, the contribution by the ear was still higher in N.P. 710.

It was shown last season that by puncturing the peduncle and defoliation, varieties like N.P. 710 and N.P. 52 suffered less in yield than Punjab 9D, Agra Local and N.P. 165 (mother shoots only). The experiment was repeated this season with N.P. 165, N.P. 52, and N.P. 710, and mother shoots as well as tillers were included in the experiment which consisted only of two treatments, viz., control and defoliation plus puncturing.

The grain yield in gms. per plant is given below :

	N. P. 165	N. P. 710	N. P. 52
Control	4·07	5·23	5·23
Treatment	2·46	3·95	3·75
Critical difference		(P=0·05)	0·63

It will be seen that the yield of variety N.P. 165 suffered the most due to defoliation and puncturing, the reduction being 40, 25 and 28% for N.P. 165, N.P. 710 and N.P. 52 respectively. Both the shoot number at the commencement of the experiment and the ear number at harvest were equal in all the varieties under both treatments, with the exception that in variety N.P. 165 ear number was substantially reduced (by about 16%) and hence also the yield per ear due to defoliation and puncturing. It would seem that varieties like N.P. 710 and N.P. 52, in which the ear makes a relatively larger contribution to grain weight, yield better when assimilation in, and transport from, the shoot are checked.

Study of the influence of light and temperature on growth and development :

(*a*) In the last year's report the possibility was indicated of raising three generations of wheat in a year and thus hastening the breeding programme. During the year under report 3 generations of 4 crosses of wheat were raised between July, 1949 and April, 1950 and two generations of 8 other crosses were raised between September 1949 and April 1950.

(*b*) In an experiment with 3 sowing dates, viz., 15th November, 5th December and 26th December and 5 varieties, viz., Baluchistan 16, C 228, CPH 47, N.P 165 and Punjab C591 the yield varied as :

Sowing date	Order of varieties
15th November 1949 ..	.. Baluchistan 16, N.P. 165, C 228, CPH 47, C 591
5th December 1949 ..	.. CPH 47, C228, NP. 165, Baluchistan 16, C591, C 591, C228, N.P. 155, Baluchistan 16, CPH 47

The yield of Baluchistan 16 suffered progressively with delay in sowing, that of CPH 47 suffered significantly at the third sowing, whereas those of C 228 and C 591 did not differ significantly with sowing dates. The 1,000 grain weight of Baluchistan 16 suffered the most among all the varieties due to delay in sowing and that of CPH 47 also suffered considerably at the third sowing. Observations on the onset of the reproductive phase, ear emergence and anthesis did not indicate any particular delay in these developmental stages in the case of these two varieties. Evidently the processes concerned with grain filling were more adversely affected by the prevailing environmental conditions in these two varieties.

Physiological aspects of plant nutrition :

In an experiment with three levels of nitrogen, *viz.*, 0, 20 and 40 lbs. of nitrogen per acre and three varieties, *viz.*, N. P. 165, N. P. 710 and N. P. 52, it was found that N. P. 710 absorbed the highest amount of nitrogen and N. P. 165 the least. The yields of N. P. 165 and N. P. 710 were about equal, while that of N. P. 52 was the lowest. Tiller production was the lowest in N. P. 165, thus accounting for its low uptake of nitrogen. There is, however, no apparent explanation for the higher uptake of nitrogen in N. P. 710 as compared to that of N. P. 52, as tiller production was practically identical in these two. It would appear that N. P. 165 utilized nitrogen most efficiently.

Plant Hormones :

An experiment was carried out with an early (N. P. 165), medium (C228) and late (S40) variety of wheat, to see the effect of dipping cut tips of leaves in hormone solution. The treatments were started about 3½ weeks after sowing and were continued for 7 weeks. Five concentrations of indole-acetic acid were employed,

viz., 0, 1, 10, 20 and 100 ppm. In C228, both 10 and 20 ppm. increased the grain yield over the water control significantly and this was due to increase in ear number. The maximum tiller number was also higher under these two concentrations, although the difference was statistically not significant. In S. 40, 10 ppm. alone increased the grain yield over the water control and this was due to the combined effect of ear number and grain number per ear, which individually were not significantly superior. In N.P. 165, the ear number was the highest under 20 ppm, although statistically not significant, but as some ears were damaged by birds the yield data could not be collected.

These results are apparently not entirely in agreement with those of Leopold and Thimann (1948), who using a similar technique found that low concentrations of auxin, which suppressed tillering, definitely increased the number of flower primordia in wintex barley. Further work on these lines should, therefore, be interesting.

Systematic Botany and Plant Introduction

The section of Systematic Botany commenced work as a permanent section of the Division from June 1949. The work on plant introduction is being done under an Indian Council of Agricultural Research scheme started in 1946.

Systematic Botany:

The work done comprised considerable advisory work regarding botanical names and systematic identification of a large number of plants received from all over the country. The herbarium was being enlarged and systematised. In a survey of the flora around Delhi, especially of the weeds of crop fields, over 700 plant specimens were collected, identified and mounted. About 100 specimens were received from Canada and Australia on an exchange basis.

Plant Introduction:

A total of 1167 samples of seed and other planting material, comprising cereals, millets, pulses, oil and fibre-plants, vegetables, grasses and legumes, medicinal and insecticidal plants, wild relatives of crop plants, etc., were received from various foreign countries during the year and were under study for evaluating their usefulness under Indian conditions. Suitable ones among them were under trail at a number of centres in the country.

The following is an account of observations on some of the more important materials.

A. Subsidiary food crops:

(*i*) *Sweet potato*: The collection under study comprised 58 varieties including those from America, China and South Africa. The Chinese variety, Tei-Shin-Tun White, gave the best performance in all plantings (May-August) at Delhi; it was high in yield and rich in total sugars, had less crude fibre and appeared to have good keeping quality. Performance of some of these varieties at Delhi and Coimbatore is shown below:—

Variety	Yield (lb.) per 100 plants, spaced 2′ × 1′ at	
	Delhi	Coimbatore
1. Tei-Shin-Tun white (China)	172	190
2. Jhunjania (Bihar)	134	..
3. B. 4306 (U. S. A.)	55	105
4. F3 4004 (U. S. A.)	100	140
5. Pelican Processor (U. S. A.	69	120
6. Local	35	87·5

(*ii*) *Tapioca*: Thirteen varieties from Travancore were under trial at Delhi; none of them seems suitable for growing in this area.

B. Other crops:

(*i*) *Soya bean*: The bold-seeded, early maturing bush varieties, *viz.*, Volstate, S. 100, Ogden, Earliana and Lincoln from America and Chinese Brown and Chinese Medium from China, appeared promising as short duration grain varieties. At Delhi, the crop should not be sown before the break of monsoon.

(*ii*) *Cowpeas* (*Vigna sinensis*): This Phillipine variety, the earliest in the collection and reported previously as being very suitable for sowing in rainy season seems unsuitable for growing as a summer crop at Delhi.

(*iii*) *Peas* (*Pisum sativum*): Early Badger, a wrinkled-seeded American, dwarf variety appeared very promising. It is 20-30 days earlier, at Delhi, than the standard variety, N. P. 29. A smooth-seeded tall variety from Phillipines was also promising, especially for sowing as late as December.

(*iv*) *Onion*: "Bermuda Yellow" from the Phillipines gave 25 per cent more yield than the local at Delhi; not a single plant of this variety bolted.

(*v*) *Groundnut*: Dixie Runner, an American variety, did distinctly better than two local standard varieties at Tindivanam (Madras).

(*vi*) *Grasses*: Two perennial grasses, *Pennisetum nervosum* (Uruguay) and *Setaria shacelata* (Brazil) appeared promising as drought-resistant grasses.

(*vii*) *Legumes*: *Birdsfoot trefoil* (*Lotus corniculatus*): A Canadian strain of this perennial pasture legume is considered very superior. The crop, sown in November, flowered and set abundant seed during May-June, the hottest and driest months of the year. It was also resistant to frost.

A vetch from Cyprus (*Vicia sativa*): This strain of vetch, having all the plant parts almost double the size than in the local variety, appeared most promising both in vegetative growth and seed production. It is considered worth trying in mixtures with the common *rabi* fodders *Phaseolus spp.* An erect variety of green gram, Peijao mungo-*P. aureus* and a variety of Rice Bean (*P. calcaratus*=*P. ricciardianus*) from Brazil seemed very good sources of green fodder during October-November.

Other fodder plants which merit special attention are—an American variety of *Medicago hispida* (Bur Clover), two Australian strains of "Sub-clover" (*Trifolium subterraneum*) and a stylo (*Stylosanthes guyanonsis*) from Brazil.

The Botanical Sub-station, Pusa

This substation serves as a very useful auxilliary substation of the Division of Botany for carrying out certain experiments which provide different conditions of soil and climate. The various functions of the substation include (1) the maintenance and trials of valuable indigenous and foreign collections of crop varieties and of related genera and species imported by the Division under research on plant introduction, (2) breeding work in relation to specific problems like those of disease resistance and trials of newly-evolved crop varieties, such as rust resistant wheats and linseeds, hybrid maize, hybrid brinjals, induced polyploids of crop plants, etc., (3) multiplication of pure seeds of improved N. P. types of crops for distribution, as foundation stocks, to growers especially in north-eastern India.

Apart from the botanical lines of work, the substation also offers assistance to the other Divisions of the Institute to conduct their experiments under conditions obtaining at Pusa. The unique New Manurial and Permanent Manurial and Rotation experiments, laid down at Pusa several years ago, are still continued and the

provide important material for study by the Divisions of Chemistry and Agronomy. The sub-station is also one of the important investigation centres under the recently-sanctioned Coordinated Wheat Rust Control Scheme for work on this major problem of wheat production in India.

During 1949-50, the twelve newly-evolved wheat hydrids of the Division were under trial for the third year; N. P. 710, 737, 718 and 760 were among those that did very well as compared to the controls, N. P. 52 and a local variety. A varietal-cum-manurial trial was also undertaken with these wheats for the first time, in collaboration with the Agronomy Division. The results will be confirmed by further trials. The other investigations in which the substation co-operated included preliminary trials with exotic wheats, rusts resistant wheats and some types of Sikkim and Chinese paddy as also trials of rust-resistant linseed and wilt-resistant rahar (*Cajanus cajan*) types.

Programme of Work for 1950-51

1. Improvement of wheat with special reference to resistance to rust, and yield.
2. Trials, in the States, of improved varieties of crop plants like wheat, linseed, potato, tomato etc. newly evolved at this Division.
3. Investigations on the utilization of hybrid vigour in maize and onion.
4. Inducing polyploidy in crops like brassica, gram, chillies, linseed etc., as a method of crop improvement, and trial of induced polyploids.
5. The study of the wild relatives of crop plants and their utilization in breeding superior crop plants.
6. Investigations on the improvement and application of cytological technique.
7. Studies on drought resistance in wheat: Studies under pot and field conditions will be continued.
8. Physiological analysis of factors concerned with yield: Studies on the contribution of different organs to grain yield will be continued.
9. Influence of light and temperature on development and growth: Work on raising more than one generation (wheat crosses) in a year will be continued.
10. Plant Hormones: Investigations on the role of hormones in the growth and development of different varieties of wheat will be continued.
11. Physiological aspects of plant nutrition: Studies on the relation between varietal differences in nutrient uptake and plant development will be continued.
12. Lodging in wheat: Investigations on factors concerned with lodging.
13. Introduction, maintenance and study of plant collection.
14. Trials of important collections like those of hybrid maize, and sweet potatoes.

SUGARCANE BREEDING STATION, COIMBATORE

Annual Report for the Year 1949-50

I. *Introduction*

This report includes, in addition to the work carried out at the Sugarcane Breeding Station, Coimbatore, brief references to the work done in the four schemes which form a part of the Station. The four schemes are financed by the Indian Central Sugarcane Committee and they are :—(1) Sugarcane Sub-Station, Karnal, (2) Scheme

for Research on the Physiology of Sugarcane, Coimbatore, (3) Saccharum Spontaneum Expedition Scheme, Coimbatore, and (4) Scheme of Additional Staff, Coimbatore.

Dr. T. S. Raghavan, M.A., Ph.D. (Lond.), F.L.S., F.A.Sc., was appointed to the post of Second Cane Breeding Officer and he assumed charge on 27th July, 1949. The post of Botanist, Spontaneum Expedition Scheme, remained vacant till 3rd December 1949, when Shri R. R. Panje, M.A., M. Sc., joined the post. Shri S. K. Mukherjee, M.Sc., tendered resignation of the post of Assistant Botanist in the scheme and he was relieved on 13th January, 1950. Miss R. Shah B.Ag., M. Sc. (Mich.), continued to hold the post of Physiologist temporarily pending selection of a suitable candidate by the Union Public Service Commission.

Under the orders of the Government of India, Ministry of Agriculture, dated 19th June, 1950, the Station was placed under the joint control of the Government of India and the Indian Central Sugarcane Committee.

II. SUGARCANE BREEDING

(a) *Hybridisation and selection*

The rainfall during the year was below normal but just prior to arrow emergence during the month of October, there was fairly satisfactory rain. The programmed crosses could be effected to the desired extent. The crosses effected totalled up to 80 crosses for obtaining economic seedlings and 200 crosses and selfs for genetical studies.

(*1*) *Bulk and semi-bulk scale crosses* :

With the favourable experience gained during the last two seasons regarding the type of seedlings obtained from them, the following varieties were utilised this year in the large scale crosses :—(1) Co. 638, (2) Co. 677, (3) Co. 683 and (4) Co. 685. Extensive use was made of the proven pollen parents Co. 453 and Co.617 as also of Co.290, the last mentioned being used in the crosses at the Thick Cane Area. The pistil parents used in the different combinations are (1) Co.313, (2) Co.508, (3) Co.527 and (4) Co.534. The more important of the crosses done are given below :

(1) Co. 313×Co.638, (2) Co. 464×Co. 453, (3) Co. 508×Co.638, (4) Co. 527×Co. 617, (5) Co. 534×Co. 453, (6) Co. 534×Co. 617, (7) Co. 677×Co.468, (8) Co. 677×POJ. 2961, (9) Co. 683×Co. 685 and (10) P. 4626×Co. 644.

(2) *Experimental crosses for evaluation of parents* :

The following new varieties were utilised in experimental crosses for assessing their value as parents : (1) Co. 513, (2) Co. K. 32, (3) Co. 777 and (4) Co. 800. The former two varieties are in cultivation in Bihar and are reported to be resistant to waterlogging. Co.777 is a heavy yielder while Co. 800 combines good yield with fair sucrose. The important experimental crosses effected were (1) Co. 513×Co. 617, (2) Co. 513×Co.K. 32, (3) Co. 777× Co. 313 and (4) Co. 800×S.G. 63/32.

(3) *Sorghum crosses* :

Three of the four tetraploid sweet sorghums obtained last year from U. S. A. flowered during the season and were utilised on such pollen sterile varieties at Co. 281, Co. 349 and POJ. 213. In all six different combinations were effected but it was found that the seeds were not viable and hence no germinations resulted. The crosses were effected under controlled conditions. They will be repeated next year to find out whether there is compatibility between the varieties and the Sorghums.

(4) *Bamboo crosses* :

The availability of bamboo pollen was limited as many of the clumps brought from neighbouring forest area and planted at the station, did not survive. The little pollen available was however found to be quite viable as judged by artificial culture. Four crosses were effected using Vellai, Co. 421, POJ. 213 and POJ. 2725 as pistil parents. Some seedlings have been obtained and are now in the Second Ground Nursery. In order to serve as controls, crosses were also effected between the four pistil parents and such wide genera as Coix, Maize, Sorghum, Narenga and Teosinte and the pistil parents were also selfed.

(5) *Crosses for assessing the breeding value of spontaneums* :

Twenty different crosses were effected using 13 forms of *S. spontaneum* collected by Spontaneum Expedition Scheme. The selection of the spontaneum parents was based on sucrose content as also on the likelihood of their imparting resistance to drought, salinity and waterlogging to the progeny. The crosses were effected under controlled conditions. Four thousand five hundred seedlings raised out of these crosses are under study in the First Ground Nursery.

From the Second Ground Nursery of 1948-49 season 387 seedlings were selected on the basis of their chemical analyses and have been planted in one row test plot alongside standards for comparison. The undermentioned crosses showed satisfactory sucrose content :—

(1) Katha × S. E. S. 14 (2) Katha × S.E.S. 45 (3) Katha × S.E.S. 66	.. 10 to 13 per cent sucrose.
(4) Co. 290 × S.E.S. 14	.. Maximum 13·25 per cent.
(5) B. 6308 × S.E.S. 45	.. Maximum 13·50 per cent.
(6) S.E.S. 49 × Co.419	.. Maximum 12·43 per cent.

Study of certain characters such as presence or absence of ligular process amount of wax, nature of pith, etc., was made in the above crosses.

(6) *Crosses for evolving chewing types* :

Four crosses were effected for obtaining chewing types, the soft rinded varieties Co.603, Co.743, Pundia and Fijia B being used as parents.

(7) *Nursery seedlings* :

The germination in the seed pans was very good and the mortality of seedlings was low. A total of 65,000 seedlings was transplanted into the First Ground Nursery out of which 20,000 seedlings were selected on the basis of vigour and tillering and transplanted into the Second Ground Nursery. The following combinations were found to be satisfactory from the point of view of vigour and tillering : (Co.313 × Co.617, (2) Co.464 × Co.453 and (3) Co. 534 × Co.453.

Eight hundred seedlings are now under study in the Preliminary test plot, these having been selected from out of a total of 14,000 in the Second Ground Nursery. The following combinations gave useful economic types and may profitably be repeated : (1) Co.331 × Co.285, (2) Co.421 × Co.649, (3) Co.K. 32 × Co. 285, (4) POJ. 2878 × Co.449, (5) P. 3247 × Co.467 and (6) P. 4626 × Co. 644.

(8) *Test Plots* :

From the Preliminary Test Plot of 1948-49 season, 176 seedlings were selected and planted in the Final Test Plot alongside the standards. The combinations (1) Co.508 × Co.617, (2) Co.527 × Co.453 and (3) Co.534 × Co. 453, yielded a large number of useful types. In the first cross the seedlings were rich in sucrose as also good in tillering. Out of the other two the combination Co.534 × Co.453 was better in the matter of yield and sucrose content.

(9) *Final Selections* :

With a view to giving the various State Experiment Stations a much wider choice of seedling varieties as many as 90 seedlings were raised to the status of Co. canes. Their parentages and general characteristics are given elsewhere in this report.

III. INVESTIGATIONS

(*a*) *Botanical Studies*

(1) *Starch in the genus Saccharum and its taxonomic significance* :

Studies on the occurrence of starch in Saccharum and allied genera and its significance as a specific character were continued during the year. The conclusions arrived at last year regarding the presence or otherwise of starch in fully formed internode as a definite specific character were confirmed. Chemical determinations for a quantitative estimation of starch are now in progress.

From the evolutionary point of view, the presence of starch S. Barberi is of interest. This species is said to have probably arisen by apomixis from a *S. officinarum* × *S. spontaneum* complex. Since *S. spontaneum* contains starch, it is possible that it might have imparted this character to the progeny. The absence of starch in *S. officinarum* varieties (which is an allopolyploid species) suggests a probable origin from *S. robustum* or *Sclerostachya* or *Narenga* which have been suggested by previous workers as having played a role in the evolution of *S. officinarum*. However, the presence of starch in some of the selfed progeny of *S. officinarum* as also in some seedlings of the cross *S. officinarum* × *S. officinarum* suggests the possibility of a starch accumulating form having entered into the *S. officinarum* complex. It is probable that species of *Erianthus* might have played a part.

(2) *Index of earliness in sugarcane* :

Studies were undertaken during the year to confirm the findings (Parthasarathy 1948) regarding the correlation of earliness and moisture content in sugarcane varieties. Data collected for both the mature and elongating leaf sheaths for nine early and six late varieties have not so far indicated any such relationship. The difference in moisture content between the samples of the same variety is as high as 3-4 per cent. while that between varieties is less than 2 per cent. indicating that the differences are not significant.

Further studies on the cell size of leaf and earliness have confirmed last year's findings. While the difference in size of stomata between early and late varieties is not significant, the size of the bulliform cells show a marked difference being considerably larger in the late varieties. The criterion is proposed to be applied for distinguishing early and late varieties even in the young stages of the crop.

(*b*) *Chemical studies*

The year under report was one of the driest in recent times and this was reflected in the juice analysis of the varieties. The juice quality was superior to those obtained during the last three years.

(1) *Determination of chemical constituents in the newly released Co. canes* :

The ninety Co. canes released during the year were analysed for fibre content, reducing sugars, colloids, ash and phosphates in the juice. The maximum fibre content recorded was 24·1 per cent. in Co. 834 while many of the varieties showed more than 20 per cent. The colloidal content of the varieties ranged from 0·24

per cent. to 0·76 per cent. Co. 764 and Co. 771 recorded more than 0·7 per cent. colloids in the juice. Low ash content (less than 0·4 per cent.) was recorded in ten of the varieties while Co. 748, Co. 755, Co. 764, Co. 770 and Co. 771 showed more than 0·7 per cent.

(2) *Effect of soil conditions on growth and quality of cane varieties* :

The findings of last year regarding the difference in growth and chemical composition of the juice of varieties grown in garden land and wet land were confirmed this year. Studies were undertaken to find out the available nitrogen (ammonia N_2 and nitrate nitrogen) and though there is not much difference in the total nitrogen between the two types of land, a striking difference was noticed in the nitrate nitrogen content which is greater in the garden land as shown in the following table:—

Garden land					Wet land				
Total moisture	Total N_2	Total available N_2	Amm. nitrogen	Nitrate N_2	Total moisture	Total N_2	Total available N_2	Amm. N_2	Nitrate N_2
		P.P.M.	P.P.M.	P.P.M.			P.P.M.	P.P.M.	P.P.M.
14·9	0·68%	96·13	2·8	93·33	9·86	0·83%	17·31	5.9	17·31
12·08	..	198·47	1·6	196·8	19·78		4·8	1·5	3·3
19·15	..	182·68	2·28	180·4					

It is proposed to study the difference in moisture content of the two types of land at different periods of the year.

(3) *Manufacturing qualities of Co. canes* :

With the tour to all the factory areas in Bombay and to the factories at Mandya (Mysore) and Nizamabad (Hyderabad), the Chemist has completed a tour of all the factories in Peninsular India.

In Bombay State, excepting in the few factories where POJ.2878 is still the main cane, Co.419 is the only variety that is being crushed. The recoveries in all the factories were good during the season showing an improvement of 1 per cent. over the previous year. This is due to the dry period followng the monsoon. The Kolhapur factory closed the season with 13·11 per cent. and the peak recovery obtained was 14·24 per cent. Thus the quality of the cane crushed in this factory, *viz.*, Co.419, compares favourably with that in Queensland which is famous for the high quality of cane crushed. In some of the factories, the quality has been improved by phosphate manuring done in the previous season. The deficiency of P_2O_5 in some factory areas has to some extent reflected itself in clarification of juice which is not so clear and does not settle as efficiently as usual.

A study of the performance of Co.419 and POJ. 2878 in the factories shows that in the boiling house, Co.419 gives brighter, well settled juice and the colour of the sugar is also better.

In the Mandya Sugar Factory only Co.419 is crushed. The factory has the longest crushing season, but since there is only one planting season (in February-March) and canes of from 12·22 months old are crushed resulting in overall low recovery.

The main cane in the Nizam Sugar Factory is Co.419 and its performance is satisfactory. Recoveries as high as in Bombay factories are not obtainable as Co.419 is crushed when not fully ripe as well. This is due to only one planting season as in the Mandya factory.

(c) *Cytogenetical studies**

(1) *Fundamental studies regarding the origin of Saccharum species* :

For ascertaining the homology of the second set of 5 chromosomes forming the basic complement of *S. officinarum,* crosses were effected between 50 chromosome type derivatives of *Saccharum* × *Sclerostachya* back crosses having the diploid number of *S. officinarum* chromosomes and other allied genera such as *Erianthus, Narenga* and *Zea Mays.* The seedlings are under study in the Nursery.

With a view to breaking up the amphidiploid constitution of *S. Barberi* which is believed to be a polyploid complex between *S. officinarum* and *S. Barberi,* crosses have been effected between *S. Barberi* and *S. spontaneum* (Coimbatore) on the one hand and *S. Barberi and S. officinarum* on the other. The seedlings have been planted in the nursery and it is proposed to select suitable F_1 seedlings to effect successive back crosses with the respective male parents.

Preliminary examination of the aceto-carmine smears of the pollen mother cells of a seedling of the cross S. G. 363/4 (2n=50) × *Narenga* (2n=30) (S. G. 363/4 is a plant of the second back crossed progeny of the cross *S. officinarum* × Sclerostachya) showed about 20 bodies with the configuration 5_{III}, 10_{II} and 5_I. It would appear from this that there is homology between *Sclerostachya* and *Narenga* chromosomes and also the 5 sets of chromosome belonging to the basic complement of *S. officinarum* bear homology to both *Sclerostachya* and *Narenga* chromosomes.

(2) *Inter-specific and inter-generic crosses* :

Examination of the spikelets of some F_1 plants of the reciprocal cross *Sclerostachya* × *Narenga* showed the presence of awned IV glume and in one of them exserted awns were noticed. In the selfs of *Sclerostachya* and *Narenga,* however, so far this character has not been noticed. It is just possible that the expression of the above character, *viz.,* exserted awns is controlled by complementary genes present separately in the two genera *Narenga* and *Sclerostachya.* As this feature is characteristic of the allied genus, it is hoped that further studies will shed light on the inter-relationship of the three genera-*Erianthus, Narenga* and *Sclerostachya.*

In a few F_1 seedlings of the cross *Sclerostachya* × *Narenga* villi were noticed on the back of glume I, also a feature of *Erianthus.*

(3) *Genetical studies* :

For a study of the pattern of the inheritance of characters, such as ligular process, circlet of hairs, rind colour, awnedness of IV glume etc., fifteen crosses were effected with suitable parents. A plant to plant study of the progeny is being made in the Nursery.

(4) *Chromosome studies in Saccharum and allied genera* :

The chromosome numbers of the following varieties of *S. officinarum* were determined : (*i*) Rasadali, (*ii*) Red Mauritius, (*iii*) Hotte Kabbu, (*iv*) Vadasali, (*v*) Seri Bontha, (*vi*) Poovan and (*vii*) Mogali. All of them have 2n = 80 chromosomes.

The chromosome number of one variety of *S. robustum* was found to be 2n= 72 as against 2n=84 reported in U. S. A. Presumably there are different karyotypes of this species.

Two products of ' second nobilisation ' S. G. 449/1 (S. officinarum var. Chittan × Co. 205) and S. G. 451/1 (Chittan × A_{10}) showed 134-138 somatic chromosomes indicating the functioning of the diploid egg gametes.

* Carried out by Dr. T. S. Raghavan, Second Cane Breeding Officer.

(d) *Physiological studies**

The physiological studies in relation to flowering consisted of photoperiodic, irrigation and manurial treatments for bridging the disparity in flowering between early and late varieties and inducing flowering in non-flowering varieties. In the photoperiodic treatments with 24 hour day (12 hours daylight + 12 hours artificial light) the early varieties Co.285 and Co. 421 were made to flower as late as December though there was a decrease in the flowering percentage. The treatment for a continuous period of 56 days yielded better results than that for 146 days. Mild photoperiodic treatments coupled with defoliation and root pruning increased the percentage of flowering in Co.421.

In the manurial treatments doses of nitrogen beyond 150 lbs. per acre have a tendency to delay flowering as well as decrease the percentage of flowering. In none of the treatments even upto 300 lbs. N was there any considerable delay in flowering in the early varieties Co.285 and Co. 421. Hundred lbs. N coupled with 280 lbs. $P_2 O_5$ induced considerable lateness in the variety Co.285 wherein the duration of the arrowing phase was extended to April. Late varieties did not flower in the treatments.

Two non-flowering varieties, *viz.*, Co.442 and B. 3013 were tried under conditions of waterlogging but none of them flowered.

In pot experiments it was noticed that application of horse dung manure had a tendency to induce arrowing and smudging linked with photoperiodic treatments resulted in inducing early flowering by 20 days.

Traumatic disturbances like boring holes, root pruning, partial ratooning, etc., have the effect of delaying flowering in the varieties Co. 285, Co.421 and Co.745.

(e) *Pests and Diseases*

(1) *Pests* :

The attack of the early shoot borer, *Argyria*, was not so high as compared to last year perhaps due to early planting this year, and the plants getting established before the onset of summer. Trichogramma parasites were released to check the incidence of the borer. A study of the varieties belonging to the different species of *Saccharum* with reference to the percentage of attack of the borer shows that varieties belonging to *S. sinense* are the most resistant, while those of *S. officinarum* are most susceptible, the varieties of *Barberi* and *Spontaneum* showing moderate resistance. Periodic incidence of *Argyria* on varieties has given an indication of resistant and susceptible ones and the data gathered will be utilised in drawing up a programme for breeding pest resistant varieties.

The top shoot borer, *Scirpophaga*, is not a serious pest at the station, the attack never going beyond 5 per cent. on stalk basis.

The attack of *Diatraea* at harvest time is as high as 40 per cent. on stalk basis in some varieties. It is observed that varieties with a high attack on stalk basis do not necessarily show the same degree of attack on length and internode basis.

The addition of 1/2 lb. of Gammexane P 520 to tar emulsion was effective in controlling termite attack. An experiment laid to find out whether by treating the cut ends in coal tar and dipping the setts in 0·5 per cent. solution of Gammexane and DDT (separate treatments) for 30 minutes before planting the percentage of attack could not be minimised has shown that plugging the cut ends alone is quite effective in minimising termite attack as also DDT and 666 when used separately.

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* The work described in this section was done by Miss R. Shah, Plant Physiologist, in the Scheme financed by the Indian Central Sugarcane Committee.

But when plugging is combined with 666 or DDT the attack is more as compared to plugging alone. It was also noticed that when the cut ends are plugged, the termites enter through the rind and bud even in the cuttings treated with 666 or DDT. It is possible that the termites finding coal tar very repulsive enter through the rind and bud and find that 666 or DDT at that concentration (0·5 per cent) are milder. Higher doses of the chemicals must be tried to find out their effect on termites.

(2) *Diseases* :

(*a*) *Mosaic.*—Due to careful roguing of mosaic affected plants during last year, the incidence of mosaic was comparatively less during the year. A careful watch was kept and diseased clumps rogued out. To find out whether setts of mosaic affected plants could be freed of the disease and give disease free crop by hot water treatment, setts of a few totally mosaic affected varieties were dipped for 10 minutes in hot water (55°—60°) and then planted. The germinated tillers showed the disease in the young leaves.

(*b*) *Smut.*—Smut was observed in a few varieties and the affected clumps were promptly rogued out.

Fifty nine Co. varieties of Co.213 parentage, twenty three of Co.301 parentage and 18 of Co. 331 parentage along with the three parents were tested for smut resistance. Ten one-eye setts in each variety were dipped for half an hour in smut spore suspension and then planted in the field. Any cases of smut that appeared were recorded. Eighteen varieties developed smut infection and among them were the commercial varieties Co. 301, Co. 312, Co. 513 and Co. 608, Co.636, Co. 677 and Co. 721.

One hundred and eight *spontaneums* and allied genera were also studied in the same manner. Many of the varieties have not shown any external symptoms of infection and are likely resistant to the diseases.

The study is in progress for the new Co. canes released this year.

For evolving disease resistant seedlings a beginning was made by inoculating sown fluff of two varieties (General Collections) *viz.*, Co. 419 and Co.453, known for their susceptibility to smut, with smut spore suspension four times at intervals of two days. In all two grams of spore have been used. The germination has been good but so far no smut whips have been noticed.

(*c*) *Red rot.*—For the second year in succession, 59 Co. varieties of Co. 213 parentage and Co.213 were tested in the field for resistance to red rot by inoculating them with a virulent strain of *Collectotrichum falcatum*, Went. Along with this twenty three varieties of Co.301 parentage and 18 of Co. 331 parentage were also tested as also 25 new spontaneums collected by the Spontaneum Expedition Scheme and 15 from the old collection. The linear spread of the attack was recorded six months after inoculation and the varieties classified into six groups, *viz.*, (1) Immune, (2) Resistant, (3) Moderately resistant, (4) Moderately susceptible, (5) Susceptible and (6) Highly susceptible. It was found that in 14 varieties the inoculated canes had completely dried up due to infection, indicating their high susceptibility to the disease. More than 13 varieties showed very limited infection and of these the varieties belonging to the Co. 600 and Co. 700 series are Co. 625, Co.697,Co.698, Co.699 and Co. 732.

Simultaneously with the above experiment in the field, all the varieties were tested for red rot resistance by Abbott's method of inoculating cut canes, preserving them in moist saw dust and noting the infection after 30 days. The new Co. canes were also included in the experiment.

It has been found that there is a general agreement of the results obtained from the two methods as will be seen from the following table :—

Serial No.	Comparison of methods	Total No. of varieties studied	No. of varieties which can be grouped in the same categories of resistance by the 2 methods	No. of varieties which can be grouped in adjacent categories of resistance by the 2 methods	No. of varieties which fall in widely different categories
1	Abbtt (1949) *vs.* Abbott (1950) ..	58	18	31	9
2	Field (1949) *vs.* Field (1950) ..	47	16	24	7
3	Abbott (1949) *vs.* Field (1949) ..	31	11	10	10
4	Abbott (1950) *vs.* Field (1950) ..	85	34	41	10

Since Abbott's method has the decided advantage of being done in a shorter time, it is suggested that this method may be followed for testing varieties for red rot resistance. The experiments will be repeated next year for confirmation.

Eight crosses were effected during the season with the object of evolving disease resistant seedlings. The combinations done are (1) Resistant × Resistant, (*ii*) Resistant × Susceptible, (*iii*) Susceptible × Resistant, (*iv*) Susceptible × Susceptible and (*v*) Moderately Resistant × Susceptible. Fifty seedlings in each of the crosses will be taken up at the Second Ground Nursery Stage, the clump divided into 3 parts, one going into the Second Ground Nursery as control, the second with roots into a separate plot where it will be inoculated after cane formation takes place and the third cut into one-eye setts and treated with smut spore suspension and planted.

IV. SUGARCANE SUB-STATION, KARNAL*

(1) *Live Herbarium* :

With the addition of 90 new Co. canes, the total number of varieties in the Herbarium was 839 consisting of 501 Co. canes, 121 North Indian varieties, 90 *spontaneums* and the rest exotics and miscellaneous.

(2) *Morphological descriptions* :

Morphological descriptions together with paintings and line drawings of one hundred Co. varieties were recorded during the year. A key to the identification of these varieties has been prepared.

(3) *Anatomical studies* :

The pattern of the stem epidermal peeling, while characteristic of a variety, differs among varieties in the nature and arrangement of the individual elements like cork cells, silica cells etc. Since the structure shows variation from internode to internode in the same cane it has been found desirable to standardise the portion of the cane from where the peelings are to be taken. It has been found that the peeling taken from the middle portion (opposite to bud) of the internode just above the ground level of a 10 months crop represents fairly accurately the structure of a variety. The above standard is now being adopted for the study of peelings.

(4) *Notes on early habit* :

An improved instrument has been devised by the Superintendent for measuring the angle of shoots. This instrument seeks to remove certain defects inherent in the old instrument that was in use for a long time.

*The Sub-station is financed by the Indian Central Sugarcane Committee.

V. SPONTANEUM EXPEDITION SCHEME*

The object of the Scheme is the exploration, survey and collection of the various forms of *S. spontaneum* and genera allied to *Saccharum* from the various parts of the Indian Union. During the year the States of Orissa and West Bengal and North Bihar were explored. About 130 plants were collected of which 73 were *spontaneums*, 24 were various species of *Erianthus*, 4 were specimens of *Sclerostachya fusca* and one was *Narenga* porphyrocoma. While in South India only 2 species, *Saccharum spontaneum* and *Erianthus arundinaceus* were available in Orissa, West Bengal and North Bihar at least 8 different species were collected. Two species of *Erianthus*, *viz.*, *E. fulvus* and *E. sikkimensis* and *Miscanthus nepalensis* not found in the plains were collected from the Darjeeling hills. Forms were collected from areas within reach of saline tidewater, from areas of severe frost at high elevation (6,000 ft. above sea level) and from marshy areas and lakes of stagnant water besides alluvial sands and silts which are the more common habitats of *spontaneum*.

Agro-botanical data are being taken of all the forms. Trailing forms on the whole seem to germinate more slowly than the erect and tall forms. Side shooting is a feature of trailing forms. Growth in height (or length) of stalk is not uniform in all the shoots forming a clump. There are vigorous shoots and slow growing shoots. There are slight differences between individual forms in the time when the maximum rate of growth sets in, but most forms grew out quickly in June.

It is noticed that when a collected plant is planted in pots later than the normal planting season (March) and transplanted in the field with a corresponding delay, its flowering period is delayed and often also extended, the dealy bearing a limited relationship to the delay in planting in pots. The period of arrowing as observed in forms planted at the same time (March) differs slightly between the forms, some forms arrowing as early as September and some not arrowing till December.

VI. RECEIPT AND DESPATCH OF CANES

A large number of commercial cane varieties and wild Saccharums were imported from foreign countries during the year, some of them by Air-Mail after obtaining the special permission of the Government of India. It is proposed to utilise such of these as are of promise in the breeding programme this year.

A list of the varieties received with the country of import and whether the variety has established or not is given in the following table :—

Serial No.	Name of variety	Country of import	Whether received by air or surface mail	Notes on germination	
1	2	3	4	5	6
1	T. M. 84-Imp. 1338	U.S.A.	Surface mail	Is growing well	
2	T. M. 85-Imp. 1339	Do.	Do.	Do.	
3	U. S. 4513	Do.	Air Mail	Did not germinate	Seeds
4	U. S. 4514	Do.	Do.	Do.	Do.
5	U. S. 4519	Do.	Do.	Do.	Do.
6	U. S. 4520	Do.	Do.	Do.	Do.
7	U. S. 4521	Do.	Do.	Do.	Do.
8	B. 41211—1199	Do.	Do.	Is growing well	
9	C. P. 33/224	Do.	Surface Mail	Do.	
10	C. P. 36/105	Do.	Do.	Do.	
11	C. P. 44/101	Do.	Do.	Do.	
12	C. P. 1161	Do.	Do.	Do.	

*The scheme is financed by the Indian Central Sugarcane Committee and is in charge of Shri R. R. Panje, Botanist.

1	2	3	4	5	6
13	*S. robustim* N. H. 1 ..	U.S.A.	Surface mail	Did not germinate	
14	Do. Molokai 4503 ..	Do. ..	Do. ..	Is growing well	
15	Do. Molokai 4575 ..	Do. ..	Do. ..	Do.	
16	21 N.G.1	Do. ..	Do. ..	Do.	
17	21 N. G. 57	Do. ..	Do. ..	Do.	
18	21 M. G. 58	Do. ..	Do. ..	Do.	
19	N. C. 5	Do. ..	Do. ..	Did not germinate	
20	N. C. 11	Do. ..	Do. ..	Is growing well	
21	N. C. 83	Do. ..	Do. ..	Did not germinate	
22	28 N. G. 11	Do. ..	Do. ..	Is growing well	
23	28 N. G. 12	Do. ..	Do. ..	Do.	
24	28 N. G. 13	Do. ..	Do. ..	Did not germinate	
25	28 N. G. 38	Do. ..	Do. ..	Is growing well	
26	28 N. G. 49	Do. ..	Do. ..	Do.	
27	28 N. G. 82	Do. ..	Do. ..	Did not rminate	
28	N. C. 1	Do. ..	Do. ..	D^{o}.	
29	Duruku Coqueque.. ..	Do. ..	Do. ..	.	
30	Duruku Vico Damu ..	Do. ..	Do. ..	Do.	
31	28 N. G. 7 ..	Do. ..	Do. ..	Do.	
32	Taboe glongong	Do. ..	Do. ..	Do.	
33	Cato	Do. ..	Do. ..	Is growing well	
34	Yellow Caledonia	Do. ..	Do. ..	Do.	
35	28 N. G. 38	Do. ..	Air mail ..	Do.	
36	28 N. G. 219	Do. ..	Do. ..	Do.	
37	U. S. 4647	Do. ..	Do. ..	Did not germinate	
38	B. 3439	Barbados (B.W.I.)	Surface mail	Do.	
39	B. 4098	Do. ..	Do. ..	Do.	
40	B. 34104..	Do. ..	Do. ..	Do.	
41	B. 37161..	Do. ..	Do.	Do.	
42	B. 37193..	Do. ..	Do. ..	Do.	
43	B. 41211..	Do. ..	Do. ..	Do.	
44	B. 41227..	Do. ..	Do. ..	Do.	
45	M. 73/31..	Mauritius	Air mail ..	Is growing well	
46	M. 112/34	Do. ..	Do. ..	Do.	
47	M. 112/34	Do. ..	Do. ..	Do.	
48	M. 165/38	Do. ..	Do. ..	Do.	
49	M. 171/30	Do. ..	Do. ..	Do.	
50	R. P. 8	Do. ..	Do. ..	Do.	
51	M. 76/39	Do. ..	Do. ..	Did not germinate	
52	M. 108/30	Do. ..	Do. ..	Do.	
53	M. 134/32	Do. ..	Do. ..	Do.	
54	R. P. 6	Do. ..	Do. ..	Do.	
55	S. spontaneum No. 1 ..	Egypt ..	Do. ..	Is growing well	
56	Do. No. 2 ..	Do. ..	Do. ..	Did not germinate	
57	Yellow Caledonia	Ceylon	Surface mail	Is growing well	
58	1900 seedling	Do. ..	Do. ..	Do.	
59	M. 171/30	Do. ..	Do. ..	Did not germinate	
60	M. 73/31	Do. ..	Do. ..	Do.	
61	M. 73/31	Do. ..	Do.	Is growing well	
62	1900 seedling	Do. ..	Do. ..	Do.	
63	Yellow Caledoni	Do. ..	Do. ..	Do.	
64	Mysray 112 ..	Mysore (India)		Do.	
65	Mysray 129	Do. ..	Do. ..	Do.	

As will be seen from the above table, most of the varieties sent by surface mail have failed to germinate, this being due to the drying up of the canes in transit. It takes nearly 3 months for receipt of consignments from U.S.A. It has been found that spontaneums especially do not travel well if sent by surface mail. Even in the case of consignments received by air some have failed to germinate. Hence it is necessary to import sugarcane varieties by air-mail in future.

(*b*) *Despatch*

(1) *Inland* :

(*i*) As canes : One hundred and sixty one cane varieties were sent to 27 places in the Indian Union.

Planting material of Co. 745 was sent to the Sugarcane Botanist, Jullundur, Punjab, for trial as fodder cane.

Material of Co. 559, Co. 560 and Co. 561 was sent to the Head of the Division of Agronomy, Indian Agricultural Research Institute, New Delhi.

Seventeen mosaic affected varieties were sent to the Head of the Division of Mycology, Indian Agricultural Research Institute, New Delhi, as also Co. 475.

(*ii*) As seeds : To Shahjahanpur:—Co. 464 × Co. 313 ; Co. 527 × Co. 453 and POJ. 2878 × B. 3412.

To Jullundur : Co. 312 × Co. 285 ; Co. 312 × Co. 313 ; Co. 313 × Co. 453 ; Co. 312 G.C. ; Co. 313 G.C. ; Co. L. 5 G.C. and Co. L. 9 G. C.

To Head of the Division of Mycology, Indian Agricultural Research Institute, New Delhi :—*S. spontaneum* (Coimbatore) G.C.

(2) *Overseas* :

(*i*) Cuttings of Co. 301, Co. 385, Co. 513, POJ. 105 and POJ. 234 were sent to His Excellency Ambassador Extraordinary and Plenipotentiary, Embassy for Iran, New Delhi, for transmission to Department of Agriculture, Iran.

(*ii*) Cuttings of Co. 301, Co. 352, Co. 513 and Co. 527 were sent to the Director, Plant Breeding Section, Giza, Orman, Egypt.

(*iii*) Cuttings of Co. 543, Co. 527 and Co. 617 were sent to the Botanist, Department of Agriculture, Peradeniya, Ceylon.

(*iv*) Cuttings of Co. 281, Co. 285, Co. 313 and Co. 396 were sent to the Royal Iraq Consulate General, Bombay, for transmission to Baghdad.

VII. NEW COIMBATORE CAENS

Ninety new varieties, *viz.*, Co. 746 to Co. 835 (both inclusive) were raised to the status of Co. canes during the year. This represents the largest number so far released in one year. But unlike in previous years all the Co. canes were not sent to all the State Stations. In the selection of the varieties the assistance of the Sugarcane Specialists of Bihar, Madras, Bombay and Mysore was available as also of the representatives of the Director, Sugarcane Research Station, Shahjahanpur, and the Sugarcane Botanist, Jullundur. Only such varieties out of the ninety as were wanted by them were sent to the respective State Stations. For those States which were not represented during selection time, the choice was made on the basis of the climatic conditions of the respective tracts and the performance of previous varieties.

Fifty three new Co. canes were sent to Uttar Pradesh, 66 to Bihar, 34 to Bengal, 31 to Punjab, 40 to Bombay, 35 to Madras, 26 to Hyderabad, 30 to Mysore, 30 to Madhya Pradesh and 29 to Orissa.

The parentages and general characteristics of these canes are given below.

Serial No.	Co. No.	Parentage	General characteristics
1	Co. 746 ..	Co. 349 × Co. 244	.. A Co. 312 class of cane, but with relatively less pith.
2	Co. 747 ..	Do.	.. A midseason cane with satisfactory yield.
3	Co. 748 ..	Do.	.. A Co. 421 class of cane.

Serial No.	Co. No.	Parentage	General characteristics
4	Co. 749 ..	Co. 370 × Co. 313	A Co. 421 class of cane, but somewhat earlier in maturity.
5	Co. 750 ..	Co. 370 × Co. 617	A midseason cane of satisfactory yield.
6	Co. 751 ..	[Co. 421 × (Co. 349 × Bamboo)] × Co. 557.	A late ripening cane of good yield.
7	Co. 752 ..	Do. ..	A heavy yielding late cane.
8	Co. 753 ..	[Co. 421 × (Co. 349 × Bamboo)] × Co. 617.	A thinnish cane not prone to flowering.
9	Co. 754 ..	[Co. 421 × (Co. 349 × Bamboo)] × Co. 244.	A Co. 331 class of cane, but with less pith.
10	Co. 755 ..	Do. ..	A Co. 281 class of cane, but with better yield.
11	Co. 756 ..	Co. 421 × Co. 617	A Co. 313 class of cane.
12	Co. 757 ..	Co. 421 × Co. 537	A. Co 331 class of cane.
13	Co. 758 ..	Co. 421 × (Co. 349 × Uba Marot)	A Co. 331 class of cane, but with better sugar.
14	Co. 759 ..	Co. 449 × (POJ. 2878 × Co. 285)	A late ripening variety.
15	Co. 760 ..	Co. 449 × Co. 605	A fairly vigorous cane of Co. 421 type but of spreading habit.
16	Co. 761 ..	Co. 453 × Co. 449	A vigorous cane of good yield, late in ripening.
17	Co. 762 ..	Co. 508 × Co. 301	A Co. 513 class of cane, but midseason in maturity.
18	Co. 763 ..	Do. ..	A midseason cane of moderate yield.
19	Co. 764 ..	Do. ..	A Co. 312 class of cane, but better in sugar.
20	Co. 765 ..	Do. ..	A midseason cane of satisfactory yield and fairly erect habit.
21	Co. 766 ..	Co. 508 × Co. 313	A late ripening cane of fair yield.
22	Co. 767 ..	Co. 508 × Co. 453	An early cane of Co. 281 class.
23	Co. 768 ..	Co. 527 × (POJ. 2725 × Imperata sp.)	A late cane of satisfactory yield.
24	Co. 769 ..	Co. 534 × Co. 453	A Co. 281 class of cane.
25	Co. 770 ..	Do. ..	A Co. 313 class of cane with better sugar.
26	Co. 771 ..	Co. 605 × [Vellai × Narenga) × Co. 205].	Resembles Co. 290 in colour and habit, very vigorous and heavy yielding, but low in sugar.
27	Co. 772 ..	Fiji B. G. C. × Co. 644 ..	A late ripening cane of good yield and tillering capacity, likely to lodge.
28	Co. 773 ..	POJ. 2878 × Co. 371	A Co. 527 class of cane.
29	Co. 774 ..	Do. ..	A late maturing cane.
30	Co. 775 ..	Do. ..	A promising cane of Co. 527 class.
31	Co. 776 ..	POJ. 2878 × Co. 432	A Co. 432 class of cane.
32	Co. 777 ..	(Co. 331 × S.W. 111) × Co. 644 ..	A late cane of good yield, fairly promising.
33	Co. 778 ..	(Co. 331 × S.W. 111) × N. G. 24	A Co. 331 class of cane, but with better sugar.
34	Co. 779 ..	Co. 421 × (POJ. 2878 × Co. 299)	A promising early cane of satisfactoy yield.
35	Co. 780 ..	(Co. 421 × Co. 440) × Co. 440 ..	A midseason cane of moderate yield.
36	Co. 781 ..	Do. ..	An early cane of satisfactory yield (shows a tendency for multiple bud formation).
37	Co. 782 ..	Do. ..	A midseason cane of good yield.
38	Co. 783 ..	Do. ..	An early cane of moderate yield.
39	Co. 784 ..	Co. 443 × Co. 453	A late cane of satisfactory yield.
40	Co. 785 ..	Do. ..	A promising cane of Co. 290 type.
41	Co. 786 ..	Do.	A Co. 419 class of cane, but somewhat thinner and sparser in flowering.
42	Co. 787 ..	Do. ..	A late ripening cane.
43	Co. 788 ..	Do.	A Co. 331 class of cane, but with better sugar.
44	Co. 789 ..	Co. 449 × Co. 301	A late ripening variety.
45	Co. 790 ..	Co. 449 × Co. 605	A heavy yielder late in ripening, shows a tendency to split.
46	Co. 791 ..	Co. 449 × (POJ. 2725 × Imperata sp.)	A late cane of satisfactory yield.
47	Co. 792 ..	Do. ..	A Co. 313 class of cane, but somewhat richer and better in yield.

Serial No.	Co. No.	Parentage	General characteristics
48	Co. 793 ..	(Co. 464 × Co. 440) × Co. 301 ..	A very promising cane combining high yield, sparse flowering, practically solid canes and very satisfactory sugar in January.
49	Co. 794 ..	Co. 603 × Co. 301	A fairly promising cane, late in ripening.
50	Co. 795 ..	Co. 603 × (Co. 349 × Uba Marot)	An early cane of satisfacotry yield.
51	Co. 795 ..	Co. 603 × (Co. 349 × Uba Marot)	An early cane of satisfactory yield, shows a tendency to split.
52	Co. 797 ..	Co. 603 × Co. 449	A Co. 421 class of cane, but richer and early maturing.
53	Co. 798 ..	Co. 603 × Co. 449	A thickish midseason cane of satisfactory yield.
54	Co. 799 ..	Co. 603 × Co. 453	A good late cane, sparse flowerer.
55	Co. 800 ..	Co. 603 × Co. 605	A Co. 419 class of cane, but rather late in maturity.
56	Co. 801 ..	Do. ..	A thickish early cane of satisfactory yield.
57	Co. 802 ..	Co. 603 × Fiji B.G.C.	A rich early cane, moderate in yield, thickish and short in height.
58	Co. 803 ..	Co. 603 × (POJ. 2725 × Imperata sp.)	A midseason cane with satisfatory sugar.
59	Co. 804 ..	Do. ..	A Co. 421 type, but earlier and richer.
60	Co. 805 ..	Do. ..	A Co. 419 class of cane, but somewhat earlier in maturity.
61	Co. 806 ..	Do. ..	A thin-medium type, midseason in ripening, sparse flowerer.
62	Co. 807 ..	Do. ..	A late maturing cane of Co. 419 class.
63	Co. 808 ..	Do. ..	A rich early cane.
64	Co. 809 ..	Do. ..	A medium, midseason cane with moderate yield and sugar.
65	Co. 810 ..	Do. ..	A promising midseason cane.
66	Co. 811 ..	Do. ..	A midseason cane of satisfactory yield.
67	Co. 812 ..	Do. ..	A midseason cane of good yield, shows tendency to split.
68	Co. 813 ..	Do. ..	A midseason cane of satisfactory yield.
69	Co. 814 ..	Do. ..	An early cane of satisfactory yield.
70	Co. 815 ..	Co. 603 × E. K. 28	A medium sized midseason cane of satisfactory yield.
71	Co. 816 ..	Do. ..	An early ripening variety, shows tendency to split.
72	Co. 817 ..	Do. ..	A midseason cane of good yield.
73	Co. 818 ..	Co. 603 × E. K. 28	A late cane of good yield.
74	Co. 819 ..	Fiji B.G.C. × Co. 605	A Co. 421 type, with slightly better sugar, fairly promising.
75	Co. 820 ..	Do. ..	A late cane of satisfactory yield, sparse flowerer.
76	Co. 821 ..	Do. ..	A fairly promising late variety.
77	Co. 822 ..	Fiji B. G. C. × Co. 605 ..	A late cane of sarisfactory yield.
78	Co. 823 ..	Do. ..	A midseason cane of fair yield.
79	Co. 824 ..	Fiji B. G. C. × Co. 644 ..	A late cane of good yield.
80	Co. 825 ..	Do. ..	A midseason cane of satisfactory yield.
81	Co. 826 ..	Do. ..	A midseason cane.
82	Co. 827 ..	Fiji B. G. C. × (M. 2819 × Co. 205).	A midseason cane of good yield.
83	Co. 828 ..	Do. ..	A thinnish cane, late in maturity with satisfactory yield.
84	Co. 829 ..	Do. ..	A midseason cane of satisfactory yield shows tendency to split.
85	Co. 830 ..	Do. ..	A heavy yielding late cane, sparse flowerer.
86	Co. 831 ..	Do. ..	A midseason cane of satisfactory yield.
87	Co. 832 ..	POJ. 2878 × Co. 213	An early cane of moderate yield.
88	Co. 833 ..	Do. ..	A midseason cane of moderate yield.
89	Co. 834 ..	Do. ..	A promising Co. 349 type of cane.
90	Co. 835 ..	POJ. 2878 × Co. 432	A late cane with good yield.

VIII. MISCELLANEOUS

(1) *Bulletin on Co. canes* : The bulletin on Co. canes giving morphological descriptions and agricultural characteristics of 25 varieties in cultivation is now in press.

At the request of the Cane Commissioner, Uttar Pradesh, suitable matter for a Hindi edition of the bulletin was prepared and sent to the Secretary, Indian Central Sugarcane Committee, for transmission to the Cane Commissioner.

(2) *Technical Committee on Sugarcane* : The Sugarcane Expert served as a member on the Technical Committee on Sugarcane appointed by the Government of India for enquiry into the cost of production of cane. In this capacity tours were undertaken to important cane growing districts in Madras for personal enquiry into the cost of production and a report was submitted to the Chairman.

(3) *Sugarcane Map of India* : A sugarcane varietal Map of the Union showing the acreage under cane for 1948-49 was prepared and sent to the Secretary, I.C.S.C.

(4) *Trial of other crops* : As desired by the Director, Indian Agricultural Research Institute, New Delhi, trial of different strains of Maize, Sweet potatoes, tomatoes, buckwheat, Plantago, Lathyrus, etc., was carried out and data supplied to the Head of the Division of Botany, I.A.R.I., New Delhi.

Facilities were afforded to the Head of the Division of Chemistry, I.A.R.I., New Delhi for his gram inoculation experiments.

IX. PROGRAMME OF WORK FOR 1950-51

Breeding with particular emphasis on specialised characters as " early " and " late " maturity, disease and pest resistance, non-pithy character of the stem and chewing quality.

Studies on (*i*) chemical estimation of starch in the different species of Saccharum and in inter-specific and intergeneric hybrids ; (*ii*) cell size and starch content of leaf as correlated with maturity and (*iii*) moisture content of leaf sheath as index of early maturity.

Cytogenetical studies bearing on the mode of inheritance of characters in *Saccharum* and allied genera as also on speciation in *Saccharum* and evolution of the cultivated types of sugarcane.

Physiological studies on the chemical composition of flowering and non-flowering cane varieties and the initiation of reproductive phase in non-flowering canes by photo-period treatments and chemicals.

The relationship of anatomical and other characters to diseases, pests, drought and frost resistance and their inheritance in cane hybrids.

Studies on resistance of Co. varieties and seedlings to diseases such as red rot, smut and mosaic.

Determination of albuminoids, colloids etc., in the seedling canes before they are released from Coimbatore and a study of the manufacturing qualities of the Co. canes.

The exploration and collection of wild forms of Saccharum and allied genera.

DIVISION OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
ANNUAL REPORT FOR THE YEAR 1949-50

Research

Soil Chemistry

1. *Phosphatic manuring of berseem (Series III)* : (1948-49, B. V. Subbiah and U. N. Sen Gupta)

A berseem-guar rotation is being followed for 3 years in which the berseem crop is fertilised with 50 and 100 lbs P_2O_5 per acre as super with and without 80 lbs of K_2O as potassium sulphate. The analysis of berseem crop (1948-49, 3rd year) generally confirmed the previous year's results. The phosphatic manures increased the general uptake of P_2O_5 (average 38 percent over control) but additions of potash seem to diminish it (average 10 percent over control). The 3 years' results indicate a rise in the fertility of the plots as indicated by the increased recovery of the phosphate. The wheat crop following the three years' rotation of berseem-guar, however, showed no significant difference in yield.

Soil analysis indicates that berseem where grown with phosphatic fertilisers did not appear to have made any contribution to soil nitrogen. Treatment of soils with super generally increased available P_2O_5 content.

2. *Effect of heavy dose of fertilisers with a legume (Series V) and without a legume (Series IV) in rotation on crop yields and soil fertility* : (1946-47, B.V. Subbiah and D.P. Motiramani)

Where legume was not introduced (wheat-maize rotation) in a general cropping procedure, a decrease in nitrogen (by 7 percent) and available P_2O_5 content by 22 per cent) of soils was observed even when N, P and K were supplied to soils through manures while introduction of legume (wheat-maize-peas-maize) increased the available P_2O_5 content of all soils under manurial treatments (average 44 percent over control).

Agricultural Chemistry

3. *Studies on green manure plants* : (1948-49, M. A. Idnani and B. V. Subbiah)

(*a*) *Studies on wild leguminous plants* : Loppings and leaves of wild leguminous plants and trees have been found to contain manurial ingredients in appreciable quantities comparable to the cultivated green manure crops.

Nitrification experiments conducted on these showed that with an initial N content of over 2·6 percent, the material nitrified to the extent of 46-54 percent while those containing less than 2·1 percent released 22 percent of their nitrogen.

(*b*) *Suitability of different rabi legumes for green manuring* : The following different varieties of *rabi* leguminous crops are being examined for their comparative values for green manuring purpose : *Senji*, berseem, field peas, lentil, gram, *methra* and lathyrus sativa. Application of phosphatic fertilizers markedly improved the yield (by 10–70 percent) as well as phosphate contents of these crops. Berseem received two cuts for fodder. The third cut buried, as green manure, contained still the highest amounts of nutrients (110 lbs N, 21·0 lbs P_2O_5 and 84·0 lbs. K_2O per acre).

(*c*) Chemical composition of 25 varieties of sunnhemp : In a preliminary trial 25 varieties of sunnhemp were grown for studies on their comparative value for green manuring. The promising varieties for green manuring from the points of view of crop yield and N content were U.P. 5-2, (N-3·4 percent), Assam 5 (N-3·06 percent) and D11 (N-3·15 percent). The fibre contents of the varieties examined ranged between 10 percent to 18·0 percent.

4. *Conservation of human urine as manure* : (1948-49, M. A. Idnani)

Trials on the conservation of human urine and the special hygienic apparatus Agri-San Urinal designed for collection of urine have been reported last year. Pot experiments on wheat showed the superiority of urine absorbed materials to sulphate of ammonia (by 15 per cent). Composting experiments with urine for six weeks have shown that 25–50 per cent of the added nitrogen was lost while when leaves were repeatedly soaked and dried in the sun only 8 percent of the added nitrogen was lost.

Soil Fertility

5. *Raised plat (lysimeter) experiments on the building up of soil fertility by phosphatic fertilisation of legumes in rotation (Berseem-cowpea-wheat-cowpea) compared to purely cereal rotation (wheat-maruwa-wheat-maruwa)* :—(1945-46, H.D. Bhowmik, W. V. B. Sundara Rao and A. B. Ghosh)

Phosphate applied at the rate of 200 lbs P_2O_5 per acre to berseem in the 2 years—4 course rotation of berseem-cowpea -wheat-cowpea had its residual effect in increasing the yield of cowpea by about 157 percent. In the purely cereal rotation the yield of wheat (Rabi 1949-50) was maximum with N + P, followed by P and by N.

Micronutrients

6. *Mineral nutrient deficiencies in citrus (Scheme of Research on minor or trace elements in Indian soils and plant nutrition—I.C.A.R.)* : (1945-46, N. P. Datta, K. L. Nayar, B. N. Mullick and S. B. Shome).

Soil and plant samples were collected from Jullundur and Attari in the Punjab (I) and from Coorg. The symptoms of deficiency diseases in citrus in the Punjab (I) were found to be mottling, *i.e.*, yellow areas in between the veins. The affected plants had a bushy appearance and the leaves showing deficiency were much smaller and narrower in size. In Coorg the symptoms observed were also yellow interveinal chlorosis, the affected leaves being small, pointed and narrow.

The soils at Satgudi are alkaline (7·3 to 8·3). Soils from places where 'fruit shedding' occurs contain much less clay (by 20 percent) in the upper two layers than those where it does not occur. On the other hand the soils of those areas where die-back and mottle leaf have been reported do not show marked difference in mechanical fractions. Total N + Organic matter are nearly the same in both the healthy and diseased soil samples. The Zn content is higher (by 2 p.p.m. at 0–6″ and 75 p.p.m., at 6″–12″) in the healthy soils than in diseased ones. This is in agreement with the results of leaf analysis reported previously.

The soils from Haradur (Coorg) were slightly acidic in nature (pH 6·0–7·01) and had low available P_2O_5 (·002–·0004 percent) and base exchange capacity (6·5–10·85 m.e/100 gms). The low base exchange capacity inspite of high percentage of clay (30 percent in the top layer) indicates the presence of kaolinitic minerals. The soils are high in total Mn content (1500-360 p.p.m.) but very low in the active fraction (35·8–8·5 p.p.m) which points to a possible Mn deficiency (Cf. analyses of healthy and diseased samples of leaves for Mn and response to Mn injection and spray reported last year). Total Zn content is higher in the healthy soils than in the diseased on es (60 p.p.m. for Kiggal, 100 p.p.m. for Hoddur) than in the diseased ones (20 p.p.m. for Kiggal and 57 p.p.m. for Hoddur) obtained from Kiggal and Hoddur. Leaf samples from Sanivarsanthe, Karkalli and Hosakote showed higher percentage of ash, CaO and higher content of Zn in the healthy samples. Besides, samples from Sanivar-sano the and Hosakote were low in Mn and Karkalli and Hosakote in Cu. In Nopakulu diagnostic injection and spray treatments indicated a response to Zn.

The soils from Punjab (I) have a low base exchange capacity and the organic matter content is nearly the same in both healthy and diseased ones. Diagnostic injections and spray treatments carried out in Attari and Jullundur showed a response to Zn.

6. *Work on grasses, forage crops concentrates and mineral feeds* : (1948-49, N. P. Datta, and N. R. Datta Biswas)

16 grass samples at three different stages of growth (*i.e.*, young, preflowering and flowering) from IARI grass nursery, five forage crops, nine concentrates, three mineral supplements and one mineral mixture were analysed for cobalt and copper. From the results it was observed that all the grasses are sound in the young stage, but some at the flowering stage are either bordering on the marginal side or become deficient. All these grasses show a gradual decrease in their copper and cobalt content with increasing age. All the forage crops studied contained sufficient amount of Co and Cu. The legumes are the best with respect to such elements. The concentrates are quite good in Co contents but their Cu values are marginal or sound. The oil cakes are considerably rich and will work as very good supplement for poorerq ualities of cattle feeds. Chalk powder is very rich with respect to Cu and sound in Co. Sambar salt and rock salt have marginal values for Cu and sound values for Co.

Soil Survey

The work on some of the projects started in the previous year was continued. A few new areas taken up during the year under report are mentioned below :—

1. Sehore, Bhopal State	Reconnaissance soil survey of nearly 4,500 acres to investigate the reasons for low yield of sugar and the failure in tillering of plant cane.
2. Delhi District	Reconnaissance soil survey of villages lying north and south of Delhi and along the Jamna river.
3. Mehrauli Area	Contour bunding and soil conservation survey (jointly with the Delhi Administration).
4. Central Potato Research Institute, Patna	Detailed soil survey of 30 acres of farm area to assess the soil characteristics.

7. *I. A. R. I. Farm Delhi* : (1947-48, R. V. Tamhane and B. S. Gupta)

It was reported last year that intensive levelling carried out at the time of lay out of the farm area resulted in a considerable heterogenity of the soil. During the year under report studies were made of soil profiles from areas from where earth had been removed, area filled and from areas left unaltered. The morphological features of these profiles showed that from areas where there was no change the texture of the soil was sandy in the surface horizon and sandy loam in the lower horizon, whereas profile from places where soil was removed showed sandy loam texture from surface layer to a depth of about 66 inches. In profiles from filled up areas the texture was predominantly sandy loam. Further examination showed that the zone of accumulation of lime concretions (*kankar*) was generallly met with within 4 feet, in areas from where the soil was removed and zone of accumulation of concretions was noticed at a greater depth in areas marked as fill up or no change.

The development of saline patches in the farm areas has been noticed. In order to study the fluctuations of water-table in different seasons, 117 borings were examined in the months of February and March, 1950, and the minimum level was recorded as 38·2 inches in the Botany area. The water-table fluctuations study was again repeated in the month of June, 1950, the minimum water table was 4 ft. except in the plots which were irrigated previously.

8. *Karnal Substation* : (1947-48, K. V. S. Satyanarayana)

A detailed soil survey of the farm area of about 1,500 acres was completed and a provisional map showing the soil types has been prepared. Two typical soil profiles were completely analysed. The analytical data show that clay has accumulated

in the second horizon. The surface horizon is slightly acid or neutral in reaction (pH 6·3 to 7·1) and pH changes to mild alkalinity with depth (7·2 to 8·0). Soluble salts and base exchange capacity of the profile samples are low (soluble salt 0·04 to 0·08 percent, base exchange capacity 7 to 14·5) and monovalant bases are fairly high in the exchange complex (25 percent of base exchange capacity). Chemical analysis of the soils, confirmed the movement of iron and manganese and accumulation in the lower horizons, Fe_2O_3 increasing from 6·5 to 10·8 percent and Mn from 700 to 1100 p.p.m., which was earlier noticed in the field examination of profiles. The total potash content of the soils is high (2 percent and above) and total P_2O_5 content is low (0·05 to 0·07 percent). The composition of the clay is fairly uniform and silica-sesquioxide ratio is near about 2·5 in the two profiles.

9. *Rann of Cutch* : (*a*) Profile studies. (1947-48, K. V. S. Satyanarayana)

The work on this project, reported earlier, was continued. Soil profiles from Gonthana, Nanda and Lakhpat-piprala were studied in great detail. The base exchange capacities of the clays ranged between 32·0 and 38·0 milli-equivalent. Fe_2O_3 content in the clays is high in the upper horizons, whereas Al_2O_3 content is high in the lower horizon. The MgO (2·3 to 5·4 percent) and K_2O (4 to 9 percent) contents are also high. The clays also contain from 0·8 to 1·6 percent of CaO. The silica-sesquioxide and silica-alumina ratios are high (3 to 4 and 4 to 8 respectively). A high potash content (of over 4 per cent) and the base exchange capacity value suggest the presence of illite clay mineral while the high MgO content indicates the possible presence of montmorillonite group of clay mineral.

The analytical data indicates that these soils have developed under two distinct processes of soil formation, *viz.*, automorphous in the upper zone and hydromorphous in the lower zone the two conditions co-existing in the profiles.

(*b*) *Mineralogical Studies* : (1948-49, N. Sen)

The percentage of the heavy minerals is higher (about 8 to 12 percent) in the upper horizons and less (5 percent) in the lower horizons of Gonthana. The heavy fraction of Nanda and Piprala also behaves more or less in the same way with depth. This is probably due to the silting up of this portion of the Little Rann. The source of sedimentation varies from place to place and also from time to time; thus at Gonthana the heavy fraction does not vary much with depth and contains chlorite (12·30 percent) amphibole-epidote-zoisite (50–70 percent),iron ores (10-20 percent), garnet tourmaline zircon (3–5 percent). At Piprala the top four contain iron ores (1–10 percent) hornblende-epidote-zoisite (20–45 percent), garnet-tourmaline-zircon (5–8 percent, biotite (4-8 percent), while the lower three contain iron ores (17–25 percent), hornblende epidote-zoisite (15–20 percent), tourmaline-zircon-garnet (3–8 percent), biotite (1–4 percent). At Nanda the profile can be divided into four zones as follows :

Zone 1. Horizon 1 to 3 : poor in mica, rich in garnet zircon-tourmaline and iron ore. Presence of monazite and staurolite.

Zone 2. Horizon 9–9 : Rich in mica, absence or paucity of minerals listed above.

Zone 3. Horizon 10–13 as in one 7, but no monazite.

Zone 4. Horizon 14, as in zone 2, predominantly mica.

10. *Delhi District*: (1949-50, A. Sankaram, R. D. Tripathi and S.P. Raychaudhuri)

A reconnaissance soil survey of villages North and South of Delhi has been undertaken. As a preliminary study, six profiles have been examined, four from the northern area and two from the southern area. Primarily these are alluvial soils and subjected to flooding during monsoon months. The soils are either clay loam or loam at the top and get lighter in texture with depth and in some cases pure sand was noticed

at lower depth (between 48″–62″). The soils in general show high content of salt and the problem is chiefly to improve the drainage conditions and free it from salts. The depth of water-table from the surface is between 4 and 5 feet. Total soluble salts varied from 0·65 to 1·6 percent and sodium salts constituted to about 68·0 percent on an average of the total salts ; the pH is between 8·0 and 9·5. The base exchange capacity varied between 5·8 and 18·1 m.e. per 100 gm. soil, and sodium saturation in a few cases range between 12·7 and 38·5 percent.

The salt content of water collected from profile pits varied from 1·13 to 2·11 percent and sodium chloride was about 50 to 55 percent of the total salts.

11. *Basic soil regions* : (1949-50, L. M. Mathur and S. P. Raychaudhuri).

The available information on topography, climate, vegetation, geology and soils is under a critical study and an integrated preliminary map of India is being prepared showing the basic soil regions. Such broad demarcations will permit groupings of similar areas irrespective of State boundaries and planning for better land use.

These studies have been initiated and guided by Dr. J. N. Mukherjee, Director, IARI.

12. *Mineralogical analysis of soils* : (1948-49, N. Sen)

Mineralogical analysis of soils on both the east and west sides of the Delhi ridge and the rocks of the ridge itself show, that the minerals on both sides of Delhi ridge are not connected in any way with the rocks of the ridge and with each other. From other geological and mineralogical characteristics it is surmised that the soils on the west side are loessic and those on the east are river alluvium.

Mineralogical analysis of black soils from Padegaon, Indore, Jubbulpore and Bhopal show that soils of this region are composed predominantly of minerals of the Deccan traps, with admixture of minerals of Gondwana, Vindhyan and Archaen formations. Magnetite, epidote group, iron ore and pyroxene minerals, possibly derived from the Deccan trap, account for all the heavy minerals in Padegaon, about 80 per cent in Indore and Jubbulpore and 40-50 per cent in Hosangabad (Powerkheda) and Bhopal (Chargaon).

Physical Chemistry

13. *Electrochemical and mineralogical properties of hydrogen clays from typical Indian soils* : (1948-49, B. Chatterjee, B. B. Roy and S. C. Das)

For complete information on the development and genesis of a soil it is essential to have a knowledge of the nature of the clay mineral not only in the surface soils but also at different depths throughout the profile. With this object in view, three typical soil profiles collected from different localities, *viz.*, (*i*) black soil from Indore, (*ii*) black soil from Padegaon, and (*iii*) Delhi soil from the National Physical Laboratory area, were collected and the electrochemical and related properties of hydrogen clays prepared from them were investigated. The two black soil profiles show montmorillonite as the dominant mineral in their clay fractions, although, however, illite, to the extent of about 20 per cent is present in the Indore clays. In Delhi soil, a considerable amount of non-exchangeable potassium occurs in the clay, the top horizon containing 6·55 per cent K_2O while the lowest horizon (67-91″) 3·28 per cent This suggests that illite is a major constituent of these clays, the top horizon comprising 80 per cent of it, and the lowest horizon 40 per cent. The other constituent is montmorillonite which increases correspondingly with depth. This conclusion is confirmed by electrometeric titrations, viscosity and thermal dehydration studies.

Soil Physics

14. *Studies on the moisture status, soil structure, C/N ratios under* (*a*) *ley farming, and* (*b*) *cultural experiments* : (1949-50, B. T. Mulwani)

(*a*) The results obtained in the first year of studies indicate that introduction of grasses in farming increased the moisture retention to the extent of 20 per cent over control. Additions of organic manures like farm yard manure have further augmented the figure. The soils are sandy in nature with about 12 per cent clay and 70 to 80 per cent sand. Aggregate analysis showed that aggregates less than 0·2 mm. size contained maxium of sand while those of 3·5 to 1·0 mm. size contained a higher proportion of clay.

(*b*) *Cultivation experiments.*—The results indicate that country inversion plough drawn by bullocks helped to conserve more moisture (7·5 per cent top layer) than by the use of tractor discing (5·9 per cent top layer) and tractor inversion plough (5·8 per cent top layer).

Soil Microbiology

15. *Residual effect of superphosphate.* (1946-47, N. D. Vyas)

Application of superphosphate at two levels 60 lb. and 120 lb. P_2O_5 doses had their beneficial effect on the fifth crop of pea, the first four being pea, maize, pea and pea, not only on the yield but also on the total nitrogen fixed and the phosphate absorbed by the crop.

16. *Manurial value of Sunnhemp seeds.* (1949-50, N. D. Vyas)

Nitrogen of sunnhemp seeds has been found as nitrifiable as that of mustard cake. In fact, its manurial value on wheat proved to be better than that of mustard cake. While the mustard cake increased the yield of wheat over the control by 1·14 per cent (pot experiment) sunnhemp seeds increased it by 2·17 per cent. Also leaves of the sunnhemp plus its seeds gave an yield of 225 mds. per acre of onions against 146 mds. per acre obtained by the application of leaves alone.

17. *Preservation of Palm Juice.* (1948-49, S. C. Datta and R. S. Dewan)

Experiments with aerated Nira (treated with CO_2 in soda water bottles) showed that addition of 0·025 per cent metabisulphite was effective in suppressing bacterial growth while sodium salicylate and sodium benzoate at the same strength depressed yeast growth.

18. *Nitrogen Fixation Scheme* (1947-48, S. N. Nayar)

(*a*) Previous observations that *rahar* bears nodules only at the early stages of its growth were confirmed both by field observations and pot culture experiments.

(*b*) Inoculation of red soil with black soil of the same locality produced nodule on gram growth in red soil at Coimbatore.

Organic Chemistry

19. *Oils and Oil Seeds analysis.* (1948-49, K. C. Gulati, G. M. Chopra, A. C. Bose and B. Chatterjee).

The semi-micro method evolved for the determination of oil in oil seeds, which was reported last year, has been further applied to other small seeds and the results have been found to compare favourably with the conventional soxhlet extraction method. Taking into consideration the economy effected in chemicals, expediency of the method and reproducibility of the analytical results, the procedure is commended particularly in connection with breeding experiments.

20. *Insecticides and Fungicides.* (1948-49, K. C. Gulati and Sat Bir)

The compounds bornyl thiocyanoacetate, nopyl thiocyanoacetate and longifolyl thiocyanoacetate have proved to be effective insecticides against aphids. Lethal

doses for these compounds for the safflower aphids, *Microsiphum solidiginis*, are 0·5 per cent in case of bornyl thiocyanoacetate and nopylthiocyanoacetate and 1·3 per cent in case of longifolyl thiocyanoacetate (56·59 per cent purity).

Bornyl thiocyanoacetate (Thanite) has been obtained in 90-95 per cent yields in the laboratory. Methods for the preparation of nopyl thiocyanoacetate and longifolyl thiocyanoacetate are being investigated.

Biochemistry

21. *Chemical composition of Indian grasses.* (1948-49, N. B. Das and Narindra Nath)

Ten indigenous grasses were analysed for chemical composition in four cuttings obtained at monthly intervals in addition to the three monthly cuts reported last year. Some of the grasses, *e.g.*, *Themeda termula*, *Penisetum orientale* and *Sehima nervosum* have been found to contain high percentage of protein 12·3 per cent, 12·1 per cent and 10·7 per cent respectively, for the three varieties. As regards the total production of green matter, CaO and P_2O_5 per acre, *Themeda tremula* is the best of the ten grasses analysed this year, being 5720 lbs., 147 lbs. and 106 lbs. respectively.

22. *Biochemical studies on Tomatoes* (1947-48, M. L. Mathur)

Some hybrid varieties of tomatoes developed in the Division of Botany by crossing cultivated ones with wild varieties contain more vitamin C (38-75 mg/100g fresh material) than their cultivated ancestor (21-39 mg/100g fresh material). This confirmed the earlier work of this Institute.

23. *Chemical composition of wheat as influenced by manurial treatments.* (1948-49, N. B. Das and M. L. Mathur)

In continuation of the work reported last year, the samples of wheat grown in the permanent manurial and rotational experiments at Pusa were analysed for chemical constituents. P_2O_5 content of the grains increased when treated with phosphatic fertilisers, being maximum (1·16 per cent) with NPK treatment and minimum (0·348 per cent) with no manure. A definite correlation may be possible when the analysis of 1949-50 crop in hand is completed.

24. *Chemical composition of maize as influenced by manurial treatments.* (1949-50, A. S. Verma and N. B. Das)

Maize crop of 1948-49 grown under different treatments in the permanent manurial experiments at Pusa has been analysed for ash, crude protein, ether-extract, nitrogen-free extract, lime, phosphoric acid and phytin phosphorous. The maximum protein contents (10·27 and 10·17) were found in the crop grown with F.Y.M. at 8000 lbs. and with rape cake at 20 lbs. nitrogen respectively. The next higher contents of protein (9·99 per cent and 9·94) were in those grown with F. Y. M. at 4,000 lbs. and ammonium sulphate at 40 lbs. nitrogen.

Physics

25. *Quantitative estimation of trace elements by the spectrographic methods.* (1949-50, B. Ramamoorthy and C. Dakshinamurty)

Manganese and boron are being estimated by copper electrodes and the duplicates in each case agree within 10 per cent. The sources of error in these measurements may partly be due to the type of electrodes, photographic plate used and the background correction applied. Plant samples such as healthy and diseased citrus leaves etc. were analysed and the results obtained were found to lie within the limits of values mentioned by other investigators.

Absorption spectrophotometric technique both in the ultraviolet and visible regions was set up and standardisation of methods for the estimation of vitamin A content starting with cod liver oils is in progress.

PROGRAMME OF WORK FOR 1950-51

Research Projects

Serial No.	Title of the experiments

I. SOIL CHEMISTRY

(a) Soil Chemistry

1 Reclamation of saline and alkaline soils at Delhi and Karnal.
2 Study of Andaman soils.
3 Studies on the effect of cultivation on soil characteristics (Indian soils).

(b) Agricultural Chemistry and Soil Fertility

4 Effect of different forms of phosphates on berseem :—
  (a) Direct effect.
  (b) Residual effect.
5 Effect of low doses of phosphate application on berseem.
6 Comparative value of F.Y.M., ammonium sulphate and oil cakes on wheat.
7 Effect of different inorganic nitrogenous fertilisers on wheat.
8 Comparative values (as green manure) of different :—
  (a) Cultivated rabi legumes.
  (b) Wild legumes.
9 Response of different doses of ammonium sulphate on wheat.
10 Comparative value of different cuttings of berseem for green manuring and fodder purposes.
11 Series IV—Response of organic manures and fertilisers applied singly and in combination.
12 Effect of soaking seeds in nutrient solutions on crop growth and yield.
13 Study of utilisation of tea waste as manure.
14 Conservation and utilisation of human urine.
15 Phosphate fertilisers requirements of legumes in different soils (Pot experiments).
16 Leaf analysis studies in Pusa Permanent manurial experiments.
17 Building up soil fertility by phosphate fertilisation of legumes :—
  (a) Raised plat (Lysimeter) experiments.
  (b) Field experiments.
18 Ash experiments in pots.
19 Indicator plant studies.
20 Trial of ' Annapurna ' Manure (a patented preparation from Gramodhar Kasyalya Anand).
21 Trial of ' NOVASOL ' Manures (Preparation of Prof. Bert of France).

Serial No.	Title of the experiments
	(*c*) *Micronutrients*
22	Cobalt and copper in Indian grasses and fodders and feeds.
23	Deficiency diseases of citrus (ICAR).
24	Top yellowing of gram.
25	Sand culture experiments with trace elements.
26	Assessments of :—
	(*a*) Trace elements status of Indian soils.
	(*b*) Manganese status of Indian soils.
27	Effect of ' Alphatron ' radioactive soil stimulent (A patented preparation received through Ministry of Agriculture).
	II. SOIL SURVEY
28	Reconnaissance soil survey of :—
	(*a*) Selected areas in Delhi Province.
	(*b*) 4,500 acres of Bhopal Sugar Industries.
29	Soil Survey of :—
	(*a*) Rann of Cutch.
	(*b*) I.A. R. I. farm.
	(*c*) Karnal substation farm.
	(*d*) Central Potato Research Institute.
	(*e*) Jubbulpore Ordnance Factory area.
	(*f*) Military dairy farm at Lucknow.
	(*g*) Izatnagar.
30	Soil conservation projects.
31	Narmada Valley Irrigation Projects.
32	Identification and quantitative estimation of rock minerals present in soil and parent material.
	III. SOIL PHYSICS
33	Ley Farming Experiments.
34	Cultural Experiments.
	IV. PHYSICAL CHEMISTRY
35	Electrochemical properties of hydrogen clays from typical Indian soils.
36	Electrochemical properties of pure clay minerals singly and in mixture.
37	Exchangeable aluminium in montmorillonitic and kaolinitic clays.
38	Electrochemical and related properties of subfractions of clays and bentonites.
39	Interaction of clay minerals with micronutrient.
	V. SOIL MICROBIOLOGY
40	Utilisation of indigenous phosphate for the fixation of nitrogen through leguminous crops.

Serial No.	Title of the experiments
41	Manurial value of sannhemp seeds.
42	Study of Root nodule organisms.
43	Study of Azotobactor.
44	Nitrogen fixation scheme.
45	The function of micro-organisms in the changes of nitrogen taking place in soil and how it is affected by phosphorus.
46	Physiological studies of some of the soil micro-organisms.
	VI.—ORGANIC CHEMISTRY (Including Plant Chemistry)
47	Analytical method for oils and oil seeds.
48	Natural insecticides and fungicides.
49	Synergists of pyrethrum insecticides.
50	Synthetic insecticides and fungicides as :—
	(*a*) Terpene thiocyanates.
	(*b*) Chlorinated terpenes.
	(*c*) Organic phosphorus compounds.
	(*d*) Mercury derivatives.
51	Effect of DDT and allied insecticides on termites of sugarcane wheat, citrus etc. DDT scheme.
	VII. BIOCHEMISTRY
52	Chemical composition and nutritive value of wheat and maize as influenced by manurial treatment.
53	Mechanism of nitrification by soil percolation experiments.
54	Metabolism and nutritive requirements of Lacto-baccillus.
55	Nutritive value of tomatoes and ladies finger.
56	Amylase content and chemical composition of wheat as influenced by manurial experiment.
57	Amino-acid composition of feeds and fodder.
58	Feeding value of cereals and pulses and their substitutes as dairy feed.
59	Methods of detection of mineral oil in vegetable oils.
	VIII. PHYSICS
60	Standardization of the methods of estimation of Vitamin A and carotene by ultra violet and visible absorption spectrographic methods.
61	Quantitative estimation of manganese in soils and plants by spectrographic method.
62	Quantitative estimations of Boron, Cobalt and Molybdenum in plants and oils by spectrographic method.

DIVISION OF ENTOMOLOGY

ANNUAL REPORT FOR THE YEAR 1949-50

Research Investigations

Section of Parasitology

(A) *Fundamental studies* :

(1) Effect of low temperature on the egg-parasite, *Trichogramma evanescens minutum* :—The effect of low temperature (refrigeration) on the viability, longevity, fecundity and sex ratio of *Trichogramma* was undertaken to find out if parasitised *Corcyra* eggs cannot be successfully stored at a temperature of 10°—12°C, in a refrigerator for any length of time. The results of these studies have shown that (*a*) the most suitable stage for storing at low temperatures was 4 days after parasitisation, (*b*) the viability (percentage emergence) was not affected upto a period of 15 days of refrigeration, (*c*) the effect of refrigeration on sex-ratio was not in evidence upto 10 days, beyond which period there was a gradual increase in the percentage of females, (*d*) the longevity of adult parasites was not affected upto 15 days of refrigeration. The results clearly showed that parasitised *Corcyra* eggs, 4 days after refrigeration, can be safely stored in a refrigerator at a temperature of 10°—12°C., for about 15 days.

(2) The influence of alternate laboratory hosts upon the parasite, *Bracon gelechiae* :—The effect of the following hosts on the parasite, *Bracon gelechiae* were under investigation : *Platyedra gossypiella* (pink bollworm), *Scirpophaga nivella* (sugar cane top borer), *Plusia orichalcea* (gram leaf feeder), *Prodenia litura* (castor leaf feeder) *Dichocrocis punctiferalis* (castor pod borer) and *Corcyra cephalonica*. The studies carried out so far have shown that the most striking effects of the different hosts were morphological, physiological and behaviouristic. The size of the parasite depended on the quality and quantity of material in the host. The smallest of individuals were reared from the small hosts and the largest from large hosts. Parasites bred on pink bollworm, which is a medium-sized host, were found to be superior to those bred on *Scirpophaga nivella*, in regard to its fecundity. The rate of development of parasites bred on different hosts varied to some extent. Parasites bred on pink bollworm had the shortest life-cycle. The parasite appeared to show preference to the host on which it was reared continuously for a number of generations. The effect of different hosts was also in evidence on the sex ratio of the parasites. Experimental studies are in progress to find out the various factors which determine the sex of the parasite. Cytological evidence is also sought by histological studies.

(B) *Biological control of Sugarcane Pests* :

(*a*) *Trichogramma colonisation field experiments at Cuttack (Orissa)* :—The report from this centre is awaited.

(*b*) *Pyrilla parasite conservation experiments at Karnal* :—These experiments were repeated at Karnal during the year under report. The results are under analysis.

(*c*) *Mass breeding of parasites* :—

(i) *Trichogramma evanescens minutum* :—A large culture was maintained throughout the year. About 12 million parasites were bred during the year under report.

(ii) *Bracon gelechiae* : The parasite was bred exclusively on the laboratory host, *Corcyra cephalonica*, at the rate of about 5,000 parasites per month.

(iii) *Stenobracon deesae* :—The propagation of this parasite on the laboratory host, *Corcyra cephalonica* was continued and a culture was maintained throughout the year.

(iv) *Bracon* (=*Microbracon*) *chilonis* :—This parasite was found to attack the larvae of the maize stem borer, *Chilo zonellus*. Preliminary attempts to breed this parasite on the larvae of *Corcyra cephalonica* have been encouraging. The technique of large scale breeding is under investigation.

Insect Vectors of Virus diseases :—

(i) *Bionomics and life-history of Trialeurodes ricini M.* :—Since *T. ricini* is frequently found in association with castor plants exhibiting serious curling of the foliage, the bionomics, life-history, etc., of this species were studied in detail with a view to apply timely control measure to reduce the damage to the minimum. A single female laid upto a maximum of 92 eggs in the middle or basal regions between the major veins on the undersides of the leaves. The immature stages are also confined to this area which develops irregular depressions and eventually curling. The egg hatches in 5-9 days and the life-cycle occupies 23-71 days during April-May and December-February respectively.

(ii) *Transmission experiments* :—Transmission experiments were conducted on 10 one-month-old healthy castor seedlings grown under insect-proof conditions by transferring to them 10-20 white-flies collected from diseased castor plants. Disease symptoms similar to those found on the plants used as source of infection appeared on the recipient seedlings in 2 to 3 weeks, and they became fully diseased in 4-5 weeks.

Studies on stored grain pests and their control :—

(i) *Aplastomorpha calandrae* How. :—Further studies on the biology of this chalcid showed that it is a parasite of grub as well as pupa of both *Bruchus chinensis* and *B. analis* which are important pests of stored pulses in India. Ecological studies have shown that a temperature of 30° C. and humidity 55-60 per cent were found to be suitable for complete development of this parasite. The life-cycle of *B. chinensis* was 24-35 days and 50-86 days, and that of *B. analis* was 18-42 days and 57-92 days during May-June and November-December, respectively.

(ii) *Chaetostricha mukherji* Mani :—It is a Trichogramatid egg parasite of the above mentioned pests of pulses. The incubation period of the egg of this parasite was 16-24 hours, grub 3-4 days and pupa 2-3 days and the life-cycle was 6-7 days during April-June.

Studies on the population of potato aphids :—

A survey of the aphid population on potato crop carried out in and around Delhi revealed that the aphids, *Myzus persicae, Aphis gossypii* and *Aphis rhamni* recorded per plant were in the proportion of 0·4, 77 and 0·634 respectively. *M. persicae* infested 2·5 per cent of the plants while *A. gossypii* and *A. rhamni* infested 62·5 per cent and 2·5 per cent of plants respectively. The maximum infestation was 76·5 by *M. persciae*, 112·4. by *A. gossypii* and 73·7 by *A. rhamni* per plant between the third week of February and first week of March. A. *gossypii* disappeared first at the end of March followed by *M. persciae* leaving only a few of *A. rhamni*. On 21st January 1950, 17·5 per cent of potato plants showed virus infection which increased to 90 per cent after two months.

Physiology of pupation in fruit flies :—

In one experiment where full-grown maggots of *Asiadacus ciliatus* were ligatured in the middle and allowed to pupate, they pupated on either side of the knot. In another experiment, the body fluid of pupating maggots was injected into the

full-grown maggots, but they did not pupate except in two cases. There is some indication that the factors responsible for pupation are released into the blood stream of the maggots.

Apiculture :—

Studies on the possibilities of bee-keeping in Delhi were started with five colonies. A careful record of the flora from which the bees collected pollen and nectar was maintained. The honey bees, *Apis indica* were found to collect nectar mainly from *Syzygium cumini* (Myrtaceae), *Pongamia pinnata* (Papilionaceae) and pollen from *Zeamays* (Graminaceae) and cucurbitaceous plants, *Lagenaria leucantha* and *Momordica charantia*. The bees were doing well.

SECTION OF SYSTEMATIC ENTOMOLOGY

(i) Bruchidae :—Studies on the morphology and external genitalia of this family of pulse beetles have revealed differences in 5 genera comprising 19 species which have been described. Breeding of bruchids collected from pods of *Albizzia* sp. has brought to light a new species of the parasite, *Megastimus* which has been described.

(ii) Chaetotaxy of the larvae of *Plusia* spp., pests *of* gram, lucerne, etc., has bee nstudied with a view to prepare a Key to identify their immature stages.

(iii) Capsidae :—*Gallobelicus tenuis* Reut :- -Since the individuals feeding on tobacco and cucurbits in Delhi and other parts of India seem to differ, their morphology and external genitalia have been studied in detail to find out whether they constitute one species or two. It has been found that they are of one species and also confirmed this phenomenon by their capacity to breed together.

(iv) Pentatomidae :--*Eurygaster maura* Linn :—Hitherto this wheat pest was considered to be one species in India. Detailed studies on the morphology showed that what was considered to be one species, really constituted five varieties, viz., *maura*, *nigra*, *personata*, *pallida* and *picta*. A study of their genitalia has also confirmed this view.

(v) *Aerial insect fauna* :—To collect and identify the different species in flight with reference to altitudes, season, meteorological factors, etc., muslin bag-nets have been fixed at different heights between 30-60 ft. on buildings, and the insects captured were collected daily from the nets and recorded. So far the common species found at 30 ft. height was *Lygaeus pandurus* and at 40 ft. *Aulacophra foveicollis*. The former is a pest of linseed, cowpea, potato, etc. and the latter a pest of cucurbits. Further observations are in progress. To study insect fauna at higher altitudes, a specia apparatus known as the 'Baloon Insect-Trap' is under construction and nearing completion.

SECTION OF ECOLOGY AND TOXICOLOGY

1. *Epidemiology of cotton bollworm* :

Collection of bioclimatic data was continued and the analysis of data collected since 1942 taken up. The normal values for different weeks of the year of population per acre of *E. fabia* and E. *insulana* larvae separately, average temperature, average relative humidity and total rainfall of the week were computed. These values show a bimodal yearly population cycle for each of the two species. Beginning with the new crop, the peak of the first period of activity is reached during the second week of September for *E. fabia* and during the last week of November for *E. insulana* whereas the peak for the second period of activity is reached during the third week of May for both the species. The population of both the species reaches the first

minimum level of practically zero during the first and second weeks of February, whereas the second lowest level of about 500 per acre is reached for both the species in the third week of July.

By converting weekly population figures into logarithmic scale it was found as in the case of William's light trap catches that the fluctuations get considerably smoothened out.

2. *Effect of temperature on insects' susceptibility* :

The effect of temperature on the susceptibility of insects to insecticide dusts was studied using DDT dust and *Tribolium castaneum* adults as material. It has been shown that the temperature at which the insects are kept before the application of insecticides has a profound effect on insect susceptibility and it also modifies both the effects of temperature during insects contact with insecticide and also the effect of post contact temperature. In contradiction to what has been reported from America it has been suggested that temperature co-efficient of DDT entry into the insects' system is positive irrespective of the concentration of DDT.

3. *Effect of formulation on toxicity of insecticides* :

Studies on the effect of formulation on the toxicity of insecticides have shown that emulsions (benzene-in-water) of both DDT and gamma-BHC are more toxic to larvae of *Euproctis lunata* than suspensions of these insecticides with acetone-in-water as carrier. Further the suspension with acetone-in-water as carrier is slightly more toxic than a suspension with alcohol-in-water as carrier. The size of the particles in the suspension has been found to have a significant effect on the toxicity of suspensions. Some light has been thrown on the process by which this effect is brought about. The size of particles in an insecticide dust has also been observed to have effect on the toxicity of the dust. Finer particles of DDT dust were more toxic to *Tribolium castaneum* adults than coarser particles.

4. *Testing of chemicals for their insecticidal property* :

Eleven compounds synthesized in the Division of Chemistry were tested for their insecticidal properties and three namely bornyl thiocyanoacetate, nopyl thiocyanoacetate and longifolyl thiocyanoacetate showed some promise against aphids. Nine insecticides established in other countries were tested against the painted bug, *Bagrada* sp.

PROGRAMME OF RESEARCH WORK OF THE ENTOMOLOGY DIVISION FOR THE YEAR 1950-51

1. INSECT TOXICOLOGY

(*i*) Bioassay of insecticides.

(*ii*) Effect of concentration on temperature co-efficient of DDT action.

(*iii*) Insect cuticle in relation to insecticidal action.

(*iv*) Effect of fumigation on viability of grain seeds.

2. INSECT ECOLOGY AND EPIDEMIOLOGY

(*i*) Epidemiology of cotton bollworms.

(*ii*) Development of *Corcyra cephalonica* and *Trichogramma evanescens minutum* at different constant temperatures.

(*iii*) Ecological studies on *Hieroglyphus nigrorepletus*.

(*iv*) Aphid population on potato crop.

(*v*) Aerial insect fauna.

3. INSECT TAXOMOMY

(*a*) Cataloguing of Indian insects :—(*i*) Coccinellidae (Coleoptera), (*ii*) Pyralidae (Lepidoptera), (*iii*) Tachinidae & Asilidae (Diptera), (*iv*) Eumenidae (Hymenoptera).

(*b*) Revision of Bruchidae (Pulse beetles).

(*c*) Classification of Hymenoptera with special reference to parasitic group.

(*d*) Physiological studies :—(*i*) Factors controlling pupation of fruit flies, (*ii*) Factors responsible for the production of winged aphides.

4. INSECT PARASITOLOGY

(*a*) *Fundamental studies on insect parasitism*

(*i*) Effect of low temperature on the viability, longevity, fecundity and sex-ratio of *Microbracon gelechiae*, laval parasite of the potato tuber moth, *Ghorimoschema operculella*.

(*ii*) Ecology and biology of *Stenobracon deesae*, a larval parasite of sugarcane top-borer, root-borer and stem-borers and the maize-borer, *Chilo zonellus*.

(*iii*) Nutritional studies on the laboratory host, *Corcyra cephalonica*—Relative nutritive value of different kinds of food.

(*iv*) Influence of hosts upon their insect parasites—studies on the relationship between host physiology and the sex of the parasite.

(*b*) *Biological Control*

(*i*) Mass breeding of the host, *Corcyra* and the parasite, *Trichogramma evanescens minutum*.

(*ii*) Mass breeding of *Bracon gelechiae*, a parasite of the potato tuber moth.

(*iii*) Possibilities of mass multiplication of *Stenobracon* and other potential parasites.

(*iv*) Control of potato tuber moth, *Gnorimoschema operculella* by *Bracon gelechiae*.

5. INSECT VECTORS OF VIRUS DISEASES

(*i*) Host plants.

(*ii*) Survey of sucking types of insects.

(*iii*) Transmission experiments with vectors.

6. GENERAL BIOLOGY

(*i*) Studies on stored grain pests and their natural enemies.

(*ii*) Observations on Indian insects of economic importance :

(*a*) Pests of crops.

(*b*) Fruit pests.

(*c*) Insects pests of potatoes.

(*d*) Insect pests of sugarcane and their natural enemies.

(*e*) Predators and parasites.

(*iii*) Studies on immature stages of insects.

DIVISION OF MYCOLOGY AND PLANT PATHOLOGY

ANNUAL REPORT FOR THE YEAR 1949-50

Research

A.—Section of Plant Pathology

1. Wheat :

Loose Smut (*Ustilago tritici* (Pers.) Rostr.) :—Investigations on the Loose Smut of Wheat were continued in cooperation with the Division of Botany. Two hundred and twenty-three varieties of wheat which were inoculated with a mixture of isolates L_1 and L_2 and with L_4 last season (1948-49) were planted this year. With the mixture of isolates L_1 and L_2, 123 varieties did not take any infection, 78 varieties showed infection up to 10 per cent and 22 varieties above 10 per cent. With isolate L_4, 135 varieties did not take any infection, 74 varieties showed infection up to 10 per cent and 14 varieties showed infection above 10 per cent. One hundred and four varieties did not take infection either with the mixture of L_1 and L_2 or with L_4 ; and 31 varieties showed more than 10 per cent infection either with the mixture of L_1 and L_2 or with L_4 and may, therefore, be regarded as susceptible.

Varieties Punjab 8A, C·518 and C·591 were inoculated to serve as controls and they showed 10·9, 30·3 and 11·3 per cent infection with L_1, L_2 and 19·1, 13·4 and 5·4 per cent with L_4 respectively. During 1950, 112 varieties were inoculated with a mixture of L_1 and L_2 and with L_4.

At Hoshangabad, out of 66 C. P. varieties which were inoculated with a local collection of *Ustilago tritici* last season and planted this year, 48 varieties did not take infection, 7 varieties showed more than 10 per cent infection and 11 varieties showed infection up to 10 per cent.

Physiologic Races :—A new culture of loose smut (A·10) collected from Kufri has been established. Fourteen wheat varieties representing five species of *Triticum* were inoculated in the previous year to serve as differential hosts with isolates L_1, L_2, L_3, L_4, L_6, L_7, L_8, L_{10} and A10 and from the results it appears as if all the isolates except A10 belong to the same race. Experiment is being repeated during the year under report to obtain further information in this direction.

2. *Oats* :

Leaf-spot (*Helminthosporium avenae* Eid.) :—It had been reported last year that primary infection of oat leaf-spot increases with fall in temperature. Experiments conducted on a small scale in pots in the previous season showed lower infection in early-sown plants. The experiment was repeated in the field during the year under report. Altogether 6 plantings were done from 18th October to 28th December, 1949 with artificially infected seed. A similar set of sowings on different dates was carried out with healthy seed which had been, as a precautionary measure, previously treated with Agrosan-GN. It was observed that the incidence of disease was negligible in the sowings conducted on 18th October. Highest disease incidence of 45 per cent was observed in the sowings conducted on 19th and 30th November. No case of primary infection was, however, observed in the control plots.

3. *Barley* :

Loose smut (*Ustilago nuda* (Jens.) Rostr.) :—For the control of loose smut of barley solar treatment has been successfully employed. Infected barley seed was soaked in cold water on 23rd June, 1949 from 6 to 10 a.m. and later exposed to sun on

a brick floor from 10 a.m. to 5 p.m. The temperature of the floor during this period varied from 114·8°F. to 129·2°F. and for a short period touched 132·8°F. The air temperature, four inches above the ground level during this period, varied from 105° to 111·2°F. The seed so treated was sown in the experimental area on 17th November, 1949. The untreated seed was simultaneously sown in the two adjoining plots. The disease incidence in the treated plots was 0·0 as against 6·0 and 6·8 per cent in the two untreated plots. It would be observed that the disease can be fully controlled by solar treatment. The germination of the seed was, however, slightly reduced. It should be possible to make up for the reduction in germination by raising the seed rate.

4. *Jowar*:

(*a*) Long smut (*Tolyposporium Ehrenbergii* (Kuehn) Pat.):—Experiments conducted here on the mode of transmission of the long smut have conclusively confirmed that the disease is air-borne. It has been shown that the infection takes place either when the inflorescence is still enclosed in the boot, or about the time it emerges when the flowers are still very young. Out of a total of 64 ears inoculated with a suspension of viable chlamydospores, 33 ears gave typical infection while 61 ears which were kept as controls remained healthy. The infection appeared in two to three weeks after inoculation and the number of sori produced in individual infected ears varied from 1 to 12. The source of infection, however, is still obscure.

(*b*) Grain smut (*Sphacelotheca sorghi* (Lk.) Clinton):—Experiment conducted to determine whether solar treatment could control this disease, jowar seed artificially infected with grain smut was soaked for 4 hours in cold water and exposed to the sun on 23rd June, 1949 for 7 hours (10 a.m. to 5 p.m.). The treated seed was sown on 7th July as also untreated seed to serve as control. In different treatments tried, the incidence of the disease varied from 0·53 per cent to 4·8 per cent as against 12·3 per cent in the untreated control. It is, therefore, indicated that it may be possible to use the solar treatment successfully for the control of grain smut of jowar if a suitable schedule of treatment is worked out.

5. *Bajra*:

Smut (*Tolyposporium penicillariae* Bref.):—Further experiments on the mode of transmission have confirmed that the disease is air-borne. Evidence has also been obtained of the occurrence of secondary infection of the bajra smut, as fresh spores of *Tolyposporium penicillariae* collected from a crop sown early at the Institute Farm gave very good infection in bajra ears inoculated while they were young and still enclosed in the sheath-leaves.

6 *Sugarcane*:

Study of the diseases of sugarcane with particular reference to Red Rot and Smut, and the study of physiologic forms of the Red Rot fungus were in progress. In addition, with the collaboration of the Government Sugarcane Expert, experiments have been set up to study the inheritance of disease resistance, and to study the Red Rot and Smut resistance of certain selected cane varieties and a large number of *spontaneums* and other *Saccharum* spp. Altogether about 24,000 canes and 8,000 cane setts were inoculated in the various tests at Delhi, Karnal and Coimbatore.

(*a*) Red Rot (*Colletotrichum falcatum* Went):—In order to select resistant cane varieties for general cultivation and cane breeding work, testing of varieties for their resistance to Red Rot was continued. 231 important cane varieties have been tested so far. During the season 1949-50, 76 important parent cane varieties, including *S. spontaneum* and other *Saccharum*. spp., were tested for their resistance to Red Rot by the standard plug method. Twenty varieties proved highly resistant. These

have reacted as resistant or moderately resistant to Red Rot in the previous tests for 5 years or more. All the 76 varieties were also tested for their resistance to nodal infection which is the chief mode of infection in nature. Eight varieties reacted as resistant. These have reacted as resistant or moderately resistant in the plug method test also.

(*b*) *Physiologic Forms of the Red Rot Fungus* :—Thirty two *Colletotrichum falcatum* isolates were tested on 10 selected differential cane varieties. Judging by the linear spread of infection the light type, highly sporing isolates generally proved to be more virulent than the dark, sparsely sporing ones ; but there appears to be little specificity between the isolates and the cane varieties.

(*c*) Smut (*Ustilago scitaminea* Syd.) :—Fifty-three important parent cane varieties, including *spontaneum* and other *Saccharum* spp., were tested at Karnal for their resistance to Smut, and 56 varieties at Delhi, including those newly released by the Sugarcane Breeding Station, Coimbatore. Twenty-two cane varieties proved to be highly resistant. These varieties have reacted as resistant to smut in the previous tests for 5 years or more.

(*d*) *Evolving Sugarcane varieties resistant to Red Rot and Smut* :—The results of the Red Rot and Smut varietal resistance tests extending over 14 years have provided sufficient information regarding the resistance and susceptibility of certain cane varieties to these two important diseases. This basic information has made it possible to attempt the breeding of varieties resistant to Red Rot and Smut. During the year under report about one dozen crosses have been affected with certain selected varieties to study the inheritance of disease resistance in the progenies so that only such cane varieties that transmit the disease-resistant character to a larger proportion of their progeny are used in the future breeding work.

(*e*) *Saccharum spontaneum* smut and sugarcane smut have been proved to be identical thus indicating the possibility of *S. spontaneum* acting as collateral host of sugarcane smut.

(*f*) *Rust* (*Puccinia Kuehnii* (Krueg.) Butl.) :—The rust of sugarcane which is normally of very rare occurrence in India was reported to be widespread in the Bombay Presidency on Co. 475, a cane variety which has recently become prominent in general cultivation in the State.

7. *Gram Wilt* :

During the study of gram wilt disease, isolations from infected gram plants yielded *Fusarium orthoceras*, *Neocosmospora*, *Rhizoctonia solani*, *R. bataticola*, *Sclerotium rolfsii* and *Operculella*. Infection tests were conducted in pots with all the fungi and it was observed that *Fusarium orthoceras* successfully reproduced typical wilt, and that *Operculella Padwickii* produced symptoms closely resembling wilt. The incidence of disease in both the cases varied from 53-83 per cent. Infection in the case of other fungi varied from 5-39 per cent and the symptoms produced were different from those of wilt.

8. *Linseed* :

(*a*) *Rust* (*Melampsora lini* (Pers.) Le'v.) :—One hundred and twenty-seven cultures of linseed hybrids different from those tested during previous years were inoculated with mixture of 4 Indian physiologic races of rust both in seedling and adult stages. Altogether 1905 seedlings were tested in pots in the glass-house and 2,400 adult plants in the field. The inoculum of each of the physiologic races was multiplied on N. P. 21, a susceptible variety, in the glass-house and then mixed

prior to inoculation. One hundred and seven cultures proved to be immune or resistant both in the seedling and adult stages, ten cultures were semi-resistant in the seedling stage but became resistant in the adult stage. Two cultures proved to be susceptible while seven cultures gave mixed reaction.

(*b*) *Wilt* (*Fusarium lini* Bolley) :—Wilted linseed plants on isolation yielded a species of *Fusarium* which has been identified to be *Fusarium lini* Bolley. A few plants also yielded *Macrophomina phaseoli* (Maubl.) Ashby. Observations on the incidence of wilt show that the optimum incidence of wilt occurs in the month of March. Infection tests with *F. lini* conducted at different temperatures show that the maximum wilting occurs between 25°—28°C. In the case of *Fusarium* there is fall in growth both on the acidic and alkaline ranges.

(*c*) *Blight* (*Alternaria lini* Dey) :—The fungus causes leaf-blight and collar-rot of linseed resulting in shrivelling of the grain. The germination of seed is greatly impaired if the fungus is present in the seed coat. The cotyledons emerging from the infected seed show typical blight symptoms. When the plants were inoculated at the flowering stage with the fungus isolated from diseased plants, successful infection was obtained. In order to establish the correct identity of the causal organism and to determine the host range of different species of *Alternaria* that are morphologically similar to A. *lini*, cross inoculations were made with four *Alternaria* spp. Successful infection was obtained on linseed and *Brassica oleracea* with *A. lini* and *A. brassicae*, but not with *A. solani* or *A. tenuis*. Inoculations on potato, tomato and sugar beet plants gave negative results with *A. lini*. *Linum grandiflorum* var. *rubrum* was found to be resistant, while *Linum usitatissimum* proved susceptible.

9. *Pigeonpea* :

Wilt (*Fusarium udum* Butl.) :—Twenty varieties of pigeonpea were tested for their resistance to wilt disease both in a heavily infected field and in artificially infected soil in pots with pure cultures of the organism growing on soil-maize medium. Field tests were conducted in a permanent plot which was wilt-sick and to which infected roots of pigeonpea are added in rows every season along which sowing is to be done so as to provide as far as possible optimum conditions of infection. Five varieties, *viz.*, N.P. 41, D. 16-17-2, D. 419-2-4, C. 38-1-2 and C. 38-5 proved to be resistant.

10. *Antibiosis* :

Investigations on the analysis of factors governing suppression of activity of *Fusarium udum*, the organism responsible for pigeonpea wilt, in normal unsterilized soils were continued. Suppression of activity of *F. udum* has been explained on the basis of the activity of the associated microflora. The inhibition in cultures has been shown to be due to the metabolic products of bacteria which belong to the *Bacillus subtilis* group.

The interaction of *F. udum* and *B. subtilis* and its cultural filtrate in soil columns and by the Cholodny technique have shown that inhibitory action lasts only for a short period. Thereafter, *F. udum* begins to grow almost normally, whereas in sand columns the inhibitory action lasts longer. The multiplication of *F. udum* in soil in the presence of *B. subtilis*-A, as shown by dilution plate method, is suppressed, whereas the cultural filtrate of the bacteria is ineffective showing thereby that soil has adverse effect on the inhibitory principle in the cultural filtrate. It was found that soil when mixed with the test medium or used as a filter-bed rendered the inhibitory

principle inactive whereas the soil extract had an adverse effect on the inhibitory principle of the filterate. This indicated that the soluble salts in the soil do not play an important part in inactivating the filtrate. When the active filtrate was passed through a bed of soil or Kaolin, the inhibitory effect was lost showing thereby that the inhibitory principle in the filtrate is absorbed. When sand was used as filter-bed the reduction in the principle was low and that about 8·9 per cent of the activity as compared with control was the only loss. The change in pH brought about during filtration through soil has been shown to be ineffective as far as inactivation is concerned. Efforts to elute the active inhibitory principle from soil particles at different pH ranges were unsuccessful.

Pathogencity of *F. udum* has been shown to be adversely affected in the presence of *Rhizopus nigricans* and *Cunnighamella elegans*, whereas *B. subtilis* proved to be ineffective. It has been shown that both these fungi have a much faster rate of growth than *F. udum* both in soil and in soil extract agar. In the presence of these fungi *F. udum* also failed to colonise the wheat straw inserted in the soil.

11. *Fungicides* :

During the *kharif* season of 1949 experiments were conducted to test the relative efficacy of agrosan-GN, ceresan, spergon, barbak, copper carbonate, sulphur, semenon, mersolite-D, aagrano and mersolite-P on the stand and yield of maize (Variety Yellow N. P. 2). Seed treatment with copper carbonate, mersolite-P, barbak agrosan-GN, aagrano and spergon resulted in 13·2 , 11·6, 10·8, 9·5, 8·9, and 7·0 per cent increase in stand respectively. No significant increase in yield expressed on the basis of cob-weight was however obtained. The different seed dressing fungicides stated above, except barbak, were also tested on wheat. The percentage increase in yield of grain as a result of various treatments was as follows : ceresan 7·6, copper carbonate 3·5, aagrano 5·6, agrosan-GN 7·6, spergon 32·6, sulphur 4·9, semenon 2·1, mersolite-D 6·9, and mersolite-P 18·1. The increase in yield due to various treatments was not however statistically significant at 5 per cent level.

The relative efficacy of all the 10 fungicides was tested for the control of covered smut of oats. The percentage infection obtained in the inoculated seed, receiving various treatments was : ceresan 1·6, copper carbonate 0, barbak 4·5, aagrano 0, agrosan-GN 1·3, spergon 3·3,sulphur 1·2, semenon 0·75, mersolite-D 4·3, mersolite-P 6·6, and control 17·3. Aagrano and copper carbonate fully controlled the disease.

The relative effectiveness of different fungicides on the emergence of wheat, oat and maize seedlings as a result of treatment with different fungicides was tested under laboratory conditions in the pot-culture house. In certain cases the doses of the fungicides were also varied to see their effect. In the case of wheat, semenon (4 : 1,000), spergon (10 : 1,000), semenon (2 : 1,000), ceresan (3 : 1,000) agrosan-GN (5 : 1,000), spergon (7 : 1,000) gave 94, 91, 90, 90, 89 and 89 per cent germination as against 79 per cent in control. In oats all the fungicides tested gave better germination than the control. Highest germination of 96-97 per cent was obtained in the case of spergon, semenon, ceresan, sulphur, barbak, whereas agrosan-GN gave 94 per cent germination. Germination in the control was only 78 per cent In maize in which five fungicides in various doses were used agrosan-GN gave 99 per cent germination as against 84 per cent in the control.

Colloidal sulphur spray :—Working on the principle that effectiveness of sulphur as fungicide is correlated with the size of particle, a hydrophobic colloidal sulphur spray was prepared by using sulphur, lime and molasses, and tried in the control of wheat rusts. It was observed that 1 ; 50,000 dilution of this stock solution inhibited

the germination of uredospores of wheat rusts and 1 : 10,000 dilution induced lysis of germ tubes. For spray purposes 1 : 100 dilution was used on wheat plants raised in glazed chambers which had previously been infected with black rust. This preliminary test appeared to indicate as if reasonable control of rust had been affected. The efficacy of this method of control in the field, however, requires to be fully investigated as also in pots with spore showers provided at frequent intervals as is the case in nature.

Control of secondary infection of downy mildew of maize which appeared in an epidemic form in a 7-acre plot was successfully effected by spraying the crop with Bordeaux mixture 5 : 5 : 50. Cases of primary infection however were comparatively few and it was not possible to control the disease in such cases.

The efficacy of Dithane, Dithane + zinc sulphate + lime, Dithane + zinc sulphate + lime + D.D.T., Perenox (2 different doses), Burgundy mixture, Burgundy mixture + D.D.T. and Perelane against late blight of potato was again tested at Kufri this year. As before both Perenox and Burgundy mixture proved effective against late blight under conditions prevailing at Kufri, while Dithane used alone or in combination with zinc sulphate and lime failed to provide any protection. Average yield per 100 plants was 48 lbs. in the plots sprayed with Burgundy mixture as against 10 lbs. in the unsprayed control.

12. *Assessment of Damage* :

Experiments initiated on the lines mentioned last year to assess losses due to certain important diseases in order to enable us to determine the economic importance of any disease were continued. In the case of late blight of potato observations on the incidence of disease and the percentage of leaf area destroyed were recorded throughout the season. 95 to 100 per cent infection of leaf area brought about a reduction of 60 per cent and 25—60 per cent infection of approximately 40 per cent in yield. In the case of early blight disease of potato it was observed that 50-75 per cent infection reduced the yield by 46 per cent and 100 per cent infection by about 78 per cent.

Reduction in yield due to black rust of wheat on the basis of 1000-grain weight in relation to intensity of infection was determined in the case of two varieties of wheat, *i.e.*, Agra-local and N. P. 4. It was found that 10-25, 40-50 and over 75 per cent rust infection resulted in 11·5, 22·3 and 55·2 per cent reduction respectively in Agra local, the corresponding figures for N. P. 4 being 3·9, 16·6 and 42·2 per cent. Sampling was done from different plants in the same field receiving identical manurial, irrigational and cultural treatments.

It has also been shown that in the case of sugarcane a reduction in yield of 29·3 per cent in the case of Co. 312 and 23·1 per cent in Co. 313 occurs as a result of smut infection. Furthermore, excessive late tillering and development of lateral shoots was observed in the smutted clumps.

13. *Miscellaneous* :

(*a*) Bacterial disease of wheat (*Corynebacterium tritici* (Hutchinson) Bergey *et al*) :—The disease appears to have assumed some importance in Delhi State. The causal organism was isolated from the diseased wheat ear heads and its identity confirmed. The infection tests conducted both in pots and field have shown that the disease is associated with *Tylenchus tritici* which carry the bacteria into the plant. Repeated inoculations with pure culture of the bacterium by different methods were unsuccessful, but when galls containing mematodes were used, a high degree of infection was obtained.

(*b*) *Soft rot of vegetables* :—Potatoes collected from market were found affected by *Ervinia aroideae* (Townsend) Bergey *et al* and *Bacillus mesentricus* Trevisan, whereas organisms isolated from rotting onions belong to the genus *Pseudomonas*. The pathogenicity of the organisms isolated from potatoes and onions was established. The organism isolated from rotting peas was identified as *Erwinia caratovora* (Jones) Holland and its pathogencity established. A temperature of 20-25°C. and high humidity were found to be the factors for optimum development of the disease.

(*c*) *Airborne fungal spores* :—To enable forecasting of airborne fungal diseases, particularly rusts and also to study the variations in the fungal flora of the air in different seasons, slides smeared with vaseline were exposed in an aeroscope to catch spores in the air about 3 feet above the ground. The slides in the aeroscopes were changed twice a week. Spores of *Alternaria* and *Helminthosporium* were trapped all the year round and those of *Darluca* only during July. Thick walled uredospores of unknown rusts were caught from September to December. Uredospores of *Puccinia glumarum* were first observed on 22-26 December 1949 followed by the appearance of yellow rust on wheat on 16 January 1950, *i.e.*, about 3 weeks after the initial spore shower. Uredospores of *Puccinia graminis* and *P. triticina* were first trapped on 21st -23rd January and the rusts were observed to appear on wheat crop on 6 and 10 February respectively. During April and May spores of smuts and uredo and teleutospores of rusts were only caught on the slides.

(*d*) *Rusts on Grasses* : Last year out of 59 grasses being cultivated in the Division of Botany, *Puccinia glumarum* was found only on *Phalaris minor* and *P. graminis* was found on *Bromus mollis, B. carinatus, B. coloratus, Hordeum distichum, H. murinum, H. stenostachys, Agropyron semicostatum, Lolium perenne, Aegilops squarrosa, A. ventricosa, A. trinocilis* and *Helaria jamesii*. *Puccinia glumarum* from *Phalaris minor* has not infected wheat and is probably a different variety. *Puccinia graminis* from the grasses mentioned above has infected wheat and so belongs to *P. graminis tritici*.

(*e*) *Mould counts of sweet-potato flour* : Mould counts of samples of sweet-potato flour received from the Ministry of Food, were taken up. Eight samples of flour were assayed on 5 media. Both potato dextrose agar and Smith-Humfeld agar supported bacterial growth and assay plates containing these media gave only a few colonies of *Rhizopus* and *Aspergillus*. On medium containing potato dextrose agar plus 3 mols. of sodium chloride, only *Aspergillus* species appeared ; whereas on acidified P.D.A. both *Rhizopus* and *Aspergillus* colonies appeared freely. The flour samples were found to be rich in *Rhizopus* and *Aspergillus* spp. The species commonly encountered being *A. nigar, A. glaucus* and *A. candidus*. To accurately determine the number of mould colonies of a sample, it was found essential to culture the samples on more than one selective media suitable for giving maximum number of colonies of the predominating fungi.

(*f*) *Microflora of stored grains* : Ten samples of stored wheat collected from villages in the neighbourhood of the Institute showed heavy infestation with epiphytic fungi. *Alternaria* species constituted more than 70 per cent. of the fungal flora and *Aspergillus* spp., *Rhizopus* spp. and *Fusarium* spp. constituted 15, 10 and 5 per cent of the flora respectively. The samples collected from the Institute farm yielded only *Alternaria* spp. and *Aspergillus* spp. to the exent of 80 and 20 per cent.

Ten samples of maize seed from the neighbouring villages showed more than 80 per cent infestation with *Rhizopus* and 20 per cent with *Aspergillus*. From the samples of N.P. 2 yellow maize obtained from Agronomy Division, about 10 per cent of the samples were free from any fungus. The tests both in the case of wheat and maize

were conducted on acidified potato-dextrose-agar and 100 seeds were plated out from each sample.

(*g*) *Tobacco leaf-spot* : Leaf-spot of tobacco appeared in a severe form in the tobacco crop of the Botany Division of this Institute during March 1948. *Nicotiana rustica* and *Nicotiana tabacum* were only found affected. A species of *Alternaria* was isolated from the infected plants and the pathogenicity of the organism was established. Morphologically the two isolates from *N. rustica* and *N. tabacum* appear to be similar. The causal organism of tobacco leaf-spot failed to infect *Solanum melongena, Lycopersicum esculentum, Datura strammonium* and *Capsicum annuum* plants. The organism was found to grow best at 28-29°C. The spore size of the fungus varied appreciably on different media ; these being largest on tobacco extract glucose agar. The fungus appears to be close to *A. longipes*, the tobacco brown spot fungus.

B.—Section of Plant Viruses

14. Tomato (*Lycopersicum esculentum* Mill.) :

(*a*) Leaf curl : Last year's results indicated that the virulence of *Nicotiana* virus 10 may be reduced during passage through certain hosts. Experiments to confirm these results were conducted by testing the activity of the virus after passage through *Lycopersicum esculentum, Datura stramonium, Solanum nigrum* and *Capsicum annuum*. Severely affected tobacco shoots were grafted on healthy stocks of these plants and after the disease symptoms had appeared on these hosts, affected shoots from the new axillary growth of the stock were grafted back to healthy tobacco plants. No change in the virulence of the virus after passage through hosts other than *Capsicum annuum* was indicated. It yet requires to be found out whether the change in virulence brought about by passage through different hosts is stable. Field experiments confirm the previous findings that the disease can be kept under control by adjusting the time of sowing. Highest disease incidence of 36·6 per cent was observed in the plantings carried out on 30th September whereas the crop planted on 31st October showed only 5·6 per cent infection.

15. Sunnhemp (*Crotalaria juncea* Linn.) :

(*i*) *Mosaic:* The virus has a wide range of pH infectivity, i.e., between 1·55-9·87 and at a dilution of 1 : 10 is inactivated after treatment with 0·5 per cent copper sulphate. Alcohol 90 per cent and mercuric chloride 2 per cent as also potassium permagnate 2 per cent and sodium sulphate 2 per cent do not adversely affect the activity of the virus. *The virus particles have been found to be rod-shaped, joined end to end and arranged in nearly parallel rows ; the average measurement being about 30×150 m/μ. (*This work was conducted by the Nuclear Physics Institute, Calcutta.)

(*ii*) *Phyllody* : Transmission tests by grafting, sap inoculation and by the agency of *Bemisia tabaci* indicated that a mixture of 2 viruses is probably responsible for the disease. One of the viruses is sap-inoculable whereas the other can be only transmitted by white fly and has been established to be *Nicotiana* virus 10. Phyllody appeared to have been reproduced when viruliferous white flies were fed on sunnhemp plants which had previously been infected with the sap-inoculable virus.

16. Bottlegourd (*Lagenaria leucantha* (Duch.) Rusby):

Mosaic : *Cucumis virus* 2C is carried symptomlessly in *Nicotiana tabacum, Datura stramonium* and *Solanum nigrum*. Inoculation test conducted showed that the virus in *Nicotiana tabacum* and *Datura stramonium* is carried on the point of inoculation and fails to move into the system of the plant. It has been confirmed that the extract of *Datura stramonium* markedly inhibits the activity of the virus and the

infectivity of the virus is further affected by prolonged storage of the virus with *Datura stramonium* extract.

17. Urid (*Phaseolus mungo* Linn.) :

Mosaic : The virus was successfully transmitted by mechanical means to different hosts of the family *Leguminoseæ*. The virus lost its infectivity after exposure for 10 minutes at 60 °C. and the crude juice was rendered innocuous at a dilution of 1 : 2000. The virus remains infective for 26 hours at room temperature (15-37°C.) and is inactivated by 50 per cent alcohol, 0·5 per cent copper sulphate and 0·5 per cent mercuric chloride as also by 5 per cent carbolic acid.

18. *Miscellaneous.*

(*i*) Enation mosaic of *Hibiscus Rosa-sinensis* was successfully transmitted by grafting to *Hibiscus esculentus*, *Gossypium indicum*, *G. hirsutum*, *Sakel* cotton and *Zinnia elegans*. The disease was also successfully transmitted by *Bemisia tabaci* to *Hibiscus esculentus* and *Zinnia elegans*.

(*ii*) A mosaic disease of groundnut (*Arachis hypogaea* Linn.) was observed at the I.A.R.I. The disease is graft transmissible. Transmission test by *Bemisia tabaci* and species of aphids and *Empoasca* gave negative results.

(*iii*) Disease-free tubers of *Darjeeling Red Round* and tubers from apparently disease-free plants of *Phulwa* were raised in the glass-house. The nucleus disease-free material of *Darjeeling Red Round* was maintained and tests of *Phulwa* plants on differential hosts were continued with a view to select virus-free plants.

C.—Systematic Mycology

19. *Taxonony*

A number of specimens belonging to various genera, chiefly *Glomerella*, *Valsella Macrophomina* etc. were under study. About 15 new species have been established and 21 are new records for India. Teleutospores of *Puccinia Kuehnii* (Krueg.) Butl. on sugarcane were observed for the first time. Also studies on the genus *Colletotrichum*, of which several new hosts have been established, were continued.

20. *Indian Type Culture Collection* :

Sixty-two cultures were added to the collection during the year under report. Seventeen cultures were lost as a result of breakdown of Cool Cabinets during the summer months. The total number of cultures in the Collection now is 783. Seventy-eight cultures were supplied to research workers and industrial concerns at their requests.

The mineral oil preservation method was tested in the case of several fungi. It was found that Nujol and BOC 120 preserved the viability of some cultures for over 14 months. Suspension of spores in these oils also keeps the fungi viable for long periods. This enables one to keep such cultures in small phials or tubes as used in the Lyophil process. Certain fungi belonging to *Mucorales* were found to remain viable for over 28 months in ordinary culture. *Phytophthora infestans* (Mont.) de Bary was brought into culture. The special media tried by different investigators in this connection were used, but a medium consisting of maltose, peptone and carrot extract developed in this Laboratory was found to be more suitable.

21. *Herbarium Cryptogamie Indiae Orientalis* :

The total number of specimens in the Herbarium now stands at 19,764. Several hundred specimens collected during the year under report were examined. Hosts and fungus lists of specimens were checked up and about 7000 Card Indices were prepared. One Exsiccati set " Second Century of Fischer's Graminicolous Smuts " and 7 fascicles (II-VIII) of Bitancourt and Jenkins ' " Myriangiales Selecti Exsiccati " were added to the Herbarium.

PROGRAMME OF WORK FOR 1950-51

I. *Plant pathological investigations*

(*a*) Studies on cereal smuts.

(*b*) Determination of physiologic forms of *Ustilago tritici* (Pers.) Rostr. and study of different isolates of *Collectotrichum falcatum* Went.

(*c*) Wilt diseases of pigeonpea, linseed, til etc. Also diseases of other economic rops.

(*d*) Studies on rusts of wheat, linseed, sannhemp as also of wild grasses.

(*e*) Efficacy of different fungicides on stand, emergence and yield of crops and diseases, as also study of micro flora of seeds of economic crops. Efficacy of hydrophobic colloidal sulphur in relation to control of wheat rusts.

(*f*) Assessment of damage due to plant diseases, e.g., wheat rusts and sugarcane smut. Aerobiological studies.

(*g*) Varieties evolved by Botany Division will be continued to be tested for their resistance to diseases.

(*h*) Diseases of sugarcane—Varietal resistance for red rot and smut will be continued. Also evolving disease resistant varieties.

(*i*) Studies on microbial antagonism.

(*j*) Bacterial disease (*Coryne/bacterium tritici*) of wheat, soft rot of vegetables and red stripe disease of Sorghum, maize etc.

II. *Plant Viruses*

(*a*) Virus diseases of *Solanaceæ, Leguminoceæ* and *Cucurbitaceæ.*

(*b*) Examination of sugarcane mosaic virus for the occurrence of strains.

(*c*) Insect vectors of the viruses.

III. *Mycological Investigations*

(*a*) Taxonomy of fungi with particular reference to unidentified collections available in the Herbarium Crypt. Indi. Orient. as well as new collections. Also study of fungi of Delhi.

(*b*) Maintenance of Indian Type Culture Collection of Fungi and investigations to evolve methods for preservation of fungi.

(*c*) Additions to and maintenance of the Herbarium.

(*d*) Identifications of fungi and diseased specimens.

IV. *Miscellaneous*

Maintenance of Host Index of Fungi, preparation of card indices of species of Fungi represented in India will be continued.

DIVISION OF AGRICULTURAL ENGINEERING
ANNUAL REPORT FOR THE 1949-50

Research

Testing of Agricultural Tractors

Ferguson Tractor :—This tractor, which was tested at the Institute, is one of the thirty ordered by the Prime Minister during one of his visits to England. This model was designed to burn petrol while the later models now sold in India are started on petrol and run on kerosene. It was found during the trials, that the Ferguson tractor had advantages in quick starting and a speed of 10 miles/hour in

road transport work. It is also light in weight compared to other tractors of similar power. It has not been tried for land reclamation or opening out virgin land but it was found suitable for follow up cultivation work. The disadvantage is that standard hitch type implements cannot generally be used with advantage as special Ferguson implements have to be purchased for operation with it. The following table gives average performance of the Ferguson tractor over a period of 520 hours during 1949-50.

Performance of the Ferguson Tractor

Operation	Acres per hour	Consumption of petrol in gallons per hr.	Output in acres per gallon
Ploughing 5″ to 6″ deep	0·73	1·05	0·70
Discing 4″ deep	1·80	0·98	1·84
Grubbing	1·70	0·98	1·74

Zetorr Tactor : At the instance of the Indian importing firm of Messrs Bhagwan Dass & Co., Delhi the Zetor tractor, which has a 2 cylinder 4 stroke diesel engine of 26 B.H.P., was tested under field conditions. Although it had a diesel engine, it was found that starting the engine by hand cranking was possible by a compression-release device. Performance of the tractor was generally found satisfactory and absence of vibration at all speeds was noted. The following are typical figures of performance:—

Performance of the Zetor Tractor

Operation	Acres per hour	Consumption of diesel oil in galls. per hr.	Output in acres per gallon
Ploughing 5″ to 6″ deep	0·49	0·86	0·56
Discing	2·10	1·08	1·94
Grubbing	2·04	1·18	1·72

Some suggestions about exhaust pipe, air-intake and installation of pressure gauge were made in the report.

Costs of operation of agricultural tractors and machines

Data on the performance of the following machines were collected during the year for compilation and working out costs later :—

1. Caterpillar D-4 Tractor.
2. Oliver ' 60 ' Tractor.
3. Farmall ' H ' Tractor.
4. John Deere ' G ' Tractor.
5. Power Mower used for reaping operations.
6. Marshall Thresher.
7. Bullock Gear for operation of stationary machines.
8. Threshers from Japan.
9. Bullock Mowing Machine used for reaping grain.

Utilisation of manure from town refuse dumps

On the successful working of a proto-type machine for separating manure in town refuse dumps, designs were prepared during the year for a more comprehensive machine, which not only sieved the manure but also loaded the sieved manure into lorries or trucks. This machine was fabricated and tried at the Badli dump yard (Delhi) along with a tractor-mounted manure loader which was secured from the U.S.A. The following are the results of trials :—

1. Although the tractor-mounted manure loader is, as a machine, satisfactory, it is not suitable as a part of the sieving and elevating machine. This is because, the manure loader has to feed the hopper of the sieve intermittently.

2. The sieve itself or the rotary screen is a satisfactory machine but the engine requires to be of larger horse power.

3. The conveyor part in the machine was not satisfactory due to the raw material used and it is unlikely that it will be very useful for loading trucks.

4. The cost of operation per ton of sieved manure was found to be more than the cost by present manual methods. By using the Farmall Tractor and manure loader, the cost per ton of sieved manure was Rs. 1/14/-, while by manual labour, it was Rs. 1/4/- per ton.

Suggestions regarding the trial of alternative methods are made in the report.

Double Plough or Twin Country Plough

A double *desi* plough was designed, fabricated and tried during the previous year. Models of this plough were sent to Punjab and Madhya Pradesh with plough bottoms of that region for trials. In the meantime, clogging of trash, clods and shrubs to the framework of the plough was observed, when worked in weedy fields. The framework was re-designed during the year with a view to avoid clogging. The new model has been fabricated and the preliminary field tests are satisfactory. Incidentally, the cost of material and labour in the fabrication of the new model is also less. Action is being taken to fabricate few more ploughs of the new design for testing in the States.

Testing of agricultural implements from Japan

With a view to examine and adapt machinery from abroad to Indian agriculture, a few manually-operated machines were obtained during the year from Japan. Trials of the following machines has been completed :—

1. One-man tread paddy thresher from Japan was used for threshing paddy at Nagpur during December, 1949. It gave an output of 60 lbs. of grain per hour and the same man could continously operate it without any strain. This machine is simple in construction and is estimated to cost about Rs. 90/- by the Department of Industries, M.P. Such machines appear to be suitable for individual ownership in the paddy-producing areas and require to be popularised.

2. Hand-operated straw cutter. This machine also received from Japan is for producing *bhusa* from wheat straw. It gave an output of 10 lbs. of *bhusa* per hour and this was the same by manual operation with a hand implement (*gandasa*). Work with the machine was found more comfortable and less tiresome.

Testing of water lifts

Tests o foutput and efficiency were conducted on two models of Persian Wheels. The improved design sent for trial by a private party showed slightly higher efficiency than the conventional type. Quantities of material used in the improved design and

hence cost of material was also less in the improved design. Although there was no difference in the quality of workmanship required for both, the costs of labour in fabricating the improved model were less. However, there was a limitation in the improved model, that it could not be installed near ponds or running channels and streams. The following is a table giving comparative performance of the two water lifts which were tested :

Comperative performance of two water lifts.

Details	Improved water lift	Conventional water lift
Water level in feet	13′—6″	13′—4″
Dynamometer pull in lbs.	130	101·5
Discharge in gallons per hour	5220	4320
Horse Power input	0·885	0·85
Horse Power output	0·375	0·29
Efficiency in percent	42·2%	34·0%

Devising machinery for cultivation and harvesting of groundnuts

At the instance of the Indian Oil Seeds Committee, a survey of the existing methods and implements used in the cultivation and harvesting of groundnuts in Madhya Pradesh and Madras States was made. Details of machinery to be developed for the purpose were worked out and proposals sent to the Indian Oil Seeds Committee. The proposals included either bullock-operated or hand-operated machines for groundnut digging, groundnut picking etc. An implement known as the *bakhar*, which is similar in design to the *guntaka* of Madras, is used in the Madhya Pradesh for purposes of seed bed preparation and weed eradication. Field trials were undertaken with the *bakhar* to examine, if it could be used as a groundnut digger. This appeared to be the best available implement which may be modified for digging groundnuts. The draft and depth of digging have to be studied, before a model is built.

The separation of the groundnut pods from the vines is usually done by machines in the U.S.A. A groundnut picker received from the U.K. was tried at Tendivanam (Madras) and its work was found satisfactory. The machine costs about Rs. 3,000/- and produces 6-8 bags of groundnuts per hour. There are chances of introduction of the same as a labour-saving machine in the groundnut-producing areas of India. Details of research for developing manually-operated machines for picking groundnuts or operation of larger machines using bullock power are being worked out.

Machines for plant breeding studies.

(*a*) Details were worked out and a seed sacrifying machine needed in, the Botanical Laboratories , was fabricated. Trials of the machine are to be taken up.

(*b*) A head-thresher, which is useful for threshing the grain from the ear-heads of small grain crops, was developed. This machine is run by a $\frac{1}{4}$ H.P. motor and is also provided with a fan for separating dust and chaff.

Improved village chulla

At the instance of the Agricultural Commissioner, Indian Council of Agricultural Research model of a " Herl " stove was constructed for purpose of demonstration. This is a smokeless *chulla*, which can be constructed with local materials and no skill in construction is necessary. It is also economical in fuel consumption. Details have been given for introduction to the Rural Development Officer, I.C.A.R.

Collection of Indian ploughs :

At the instance of the Food Commissioner, a start was made in the collection of ploughs from different parts of India. This is with a view to make a study and determine any advantage of one design over the other. The question of standardisation, if any, or introducing a useful implement of one region into another are also parts of this study.

The Agricultural Implement Industry in India

After an investigation, a comprehensive report about the present status of the Agricultural Implement Industry in India was prepared. This report gives the names of the firms on a regional basis, indicating the products manufactured by them. Suggestions have been made for stepping up production in the industry and giving technical guidance for taking up new lines of agricultural implements. As a consequence of this study, an agricultural implement buyer's guide for India is now under preparation.

Measurement of irrigation water

V-notches were introduced and calibrated in the main concrete channels leading irrigation water to the farms of the Institute. This is with a view to determine the acre inches of water required for several crops.

Improvements in paddy milling

After an investigation of the machinery and methods used in the U.S.A. and Japan for milling paddy and taking into consideration the prevailing practices and machines in India, a report giving suggestions for the improvement of outturn in rice milling was prepared.

PROGRAMME FOR THE YEAR 1950-51

1. Continuation of work on the double plough or twin country plough.
2. Calculation of costs of operation by different makes of tractors and agricultural machines.
3. Trials of water lifts.
4. Devising machinery for processing bone for manurial purposes.
5. A multipurpose power unit for Indian farming.
6. Experiments on spray irrigation and costs of operation by the same.
7. Continued trials of agricultural machines from Japan.
8. Operation of stationary machines by using a bullock gear.
9. Investigations and experiments on harvesting and threshing paddy at Karnal.
10. Continued investigations on the agricultural implement industry in India.
11. Continued experiments on the reclamation of manure from town refuse dumps.
12. Use of milking machines and economics of operation by the same.
13. Any other problem which may be suggested from time to time from the Ministry of Agriculture.

APPENDIX I

Gazetted Staff

1. Director—Dr. J. N. Mukherjee, C. B. E., F. N. I., F. R. A. S. B., F. C. S.
2. Assistant Director & the Head of the Division of Botany—Dr. B. P. Pal, M. Sc., Ph. D. (Cantab), F. L. S., F. N. I.
3. Registrar—Shri N. C. Pal, M. A., B. L.
4. P. A. to the Director—Shri J. M. Banerjee, M.A.

Botany Division

1. Head of the Division—Dr. B. P. Pal (Please also see item 2 above).
2. Geneticist—Dr. N. Parthasarathy, B.A., B.Sc., (Agr.), Ph. D. (Lond.), F. N. I.
3. Plant Physiologist—Dr. R. D. Asana, M.Sc., Ph. D. (Lond.), D.I.C.
4. Cytogeneticist—Dr. P. N. Bhaduri, M.Sc., Ph. D. (Lond.), F.L.S., F.N.I.
5. Syst. Botanist—Dr. D. Chatterjee, M.Sc., Ph.D. (Lond.).
6. Asstt. Geneticist—Shri R. B. Deshpande, M. Sc., Assoc. I.A.R.I.
7. Asstt. Geneticist—Dr. F. H. Abbasi, B.Sc., Ph. D.
8. Asstt. Plant Physiologist—Shri T. J. Malkhani, M.Sc.
9. Asstt. Cytogeneticist—Shri M. J. Deshmukh, M.Sc., Assoc. I. A. R. I. (Officiated till 21-6-50 and was relieved on 22-6-50 by Dr. A. B. Joshi, the permanent incumbent on his return from training abroad).
10. Asstt. Botanist—Shri Harbhajan Singh, M.Sc., Assoc. I. A. R. I. (Plant Introduction Scheme).
11. Asstt. Botanist—Dr. G. S. Murthy M. Sc., Ph. D., Assoc. I.A.R.I. from 23-7-49.
12. Asstt. Economic Botanist—Dr. G. S. Murthy M. Sc., Ph. D., Assoc. I.A.R.I. from 23-7-49 (Maize Scheme).

Chemistry Division

1. Head of the Division—Dr. S. P. Raychoudhury, M.Sc., Ph. D. (London), D.Sc. (Lond. & Cal.), F.R.I.C. from 20-7-49.
2. Soil Microbiologist—Dr. S. V. Desai, B.Sc., Ph. D., D. Sc., D.I.C.
3. Soil Survey Officer—Dr. R. V. Tamhane (Offg.), M.Sc., Ph. D. (Lond.)
4. Biochemist—Dr. N. B. Das, Ph. D.
5. Organic Chemist—Dr. K. C. Gulati, B. Sc. (Hons. Tech.), M. Sc. (Hons.) Ph. D.
6. Physical Chemist—Dr. B. Chatterji, D. Sc. Relieved of his duties on 12-10-49 (afternoon).
7. Exptl. Physicist—Dr. C. Dakshinamurty, M.Sc., Ph. D., D. Sc.
8. Asstt. Soil Microbiologist—Dr. N. D. Vyas, M. Sc., Ph. D.
9. Asstt. Soil Survey Officer—Dr. K. V. S. Satyanarayana, B. Sc. (Agri), Ph. D., Assoc. I.A.R.I.
10. Asstt. Soil Survey Officer—Shri L. M. Mathur (Offg.), M.A., B.T., A.S.T.
11. Asstt. Organic Chemist—Dr. A. C. Bose, B.Sc. (Hons.), Ph. D., A.I.C. (Lond.)
12. Asstt. Organic Chemist (Temporary)—Dr. H. D. Bhowmick, M.Sc., Ph. D., till 21-3-50.
13. Asstt. Soil Chemist—Dr. W. V. B. Sundara Rao, M.Sc., Ph. D., Assoc. I.A.R.I. Relieved of his duties on 25-7-49 for taking up a post in the Central College of Agriculture, Delhi.
14. Asstt. Physical Chemist—Dr. B. B. Roy, M. Sc., Ph. D., A.R.I.C. (Lond.)
15. Asttt. Soil Chemist—Dr. H. D. Bhowmick officiating from 22-3-50 vice Dr. W. V. B. Sundara Rao.
16. Asstt. Agricl. Chemist—Shri M.A. Idnani, B.Sc. (Hons.), Assoc. I.A.R.I.
17. Asstt. Soil Physicist—Dr. B. T. Mulwani, B.Ag., M.Sc., Ph. D. (Lond.), D.I.C. from 22-8-49 (afternoon).

Mycology Division

1. Head of the Division—Dr. R. S. Vasudeva (Offg.), D. Sc. (Lond.), Ph. D. (Lond), D.I.C., F.N.I.
2. Asstt. Syst. Mycologist—Dr. B. L. Chona, B. Sc., Ph. D. (Lond.), D. I. C. (Lond.).
3. Asstt. Plant Pathologist—Dr. R. Prasada, M.Sc., D.Sc., (Agra).
4. Asstt. Plant Pathologist—Dr. M. L. Gattani, M. Sc., Ph. D. (Minn.).
5. Asstt. Virologist—Dr. S. P. Raychaudhuri, M. Sc., D. Phil. (Cal.), F.L.S., Assoc. I.A.R.I.
6. Asstt. Plant Bacteriologist—Dr. M. K. Hingorani, B.Sc. (Agr.), Ph. D. (Minn.), Assoc, I.A.R.I.

Entomology Division

1. Head of the Division—Dr. E. S. Narayanan (Offg.), M.A., Ph. D. (Lond.), D.I.C., F.R. E.S.
2. Syst. Entomoligst—Dr. S. Mukherjee, M. Sc., D.Sc.
3. Insect Ecologist—Dr. S. Pradhan, M.Sc., Ph. D. (Lond.), D. Sc., F.R.E.S., F.E.S.I.
4. Asstt. Syst. Entomologist—Shri B.B. Bose, B. Sc.
5. Asstt. Syst. Entomologist—Shri C.K. Samuel, B.Sc., Assoc. I.A.R.I.
6. Asstt. Insect Epidemeologist—Dr. R. P. Chaudhuri, M.Sc., Ph. D. (Lond.).
7. Asstt. Insect Physiologist—Shri Rattan Lal, M.Sc., Assoc. I.A.R.I.
8. Asstt. Sugarcane Entomologist (B.C.R.O. Scheme)—Shri T.V. Venkataraman, M. Sc., upto 31-3-50 when the Scheme was terminated.
9. Asstt. Syst. Entomologist—Shri T. V. Venkatraman, M.Sc., from 1-4-50 vice Shri B.B. Bose on leave).

Agromony Division

1. Head of the Division—Dr. T. J. Mirchandani, M.Sc., Ph. D., A.I.I.Sc.
2. Agronomist—Dr. P. C. Raheja, M.Sc., Ph. D.
3. Agronomist—Dr. N. P. Datta, M.Sc., D.Sc., A.R.I.C.
4. Agronomist—Shri J. J. Chandnani, M. Sc. (Agri.)
5. Asstt. Agronomist—Shri A. R. Khan, M.Sc., D.Sc.
6. Asstt. Agronomist—Shri R.D. Verma, B.Sc., B.Sc. (Hons.) (Ed.)
7. Asstt. Agronomist (Temp.)—Shri Y. C. Gupta B.Sc. (Ag.) from 4-1-50.
8. Asstt. Agronomist (Temp.)—Shri S. L. Relwani, B.Sc. (Ag.), from 10-8-49 to 14-12-49.
9. Asstt. Agrostologist—Shri P. M. Dabadghao, M. Sc.
10. Cattle Supdt. —Shri N. P. Fernandez, G. B. V. C. upto 28-2-50 when he proceeded on leave preparatory to retirement.
11. Cattle Supdt.—Shri U. P. Saha, G. V. S. C. (Offg.) from 29-2-50.

Agricultural Engineering Division

1. Head of the Division—Major D. T. Brown, A. M. I., Mech. E., M. I. B. A. E. upto 24-2-50 (after noon) when he proceeded on leave preparatory to retirement.
2. Head of the Division—Shri R. V. Ramiah, B. E. (Mech.), M. Sc. (A.E.), M. A. S. A. E. from 24-2-50 (afternoon).
3. Asstt. Engineer—Shri A. .K. Kaul, I.E.E.
4. Asstt. Engineer—Shri K. S. Chopra, A.M.M.E.A.

Statistic Division

1. Asstt. Statistician—Shri P. N. Saxena, M. A. (Offg.)

Sugarcane Breeding Station, Coimbatore

1. Sugarcane Expert—Shri N. L. Dutt, M.Sc.
2. Second Cane Breeding Officer—Dr. T. S. Raghavan from 27-7-49.
3. Assistant Sugarcane Expert—Shri M. K. Krishnaswamy, M.A.
4. Assistant Botanist—Shri S. K. Mukherjee, Relieved of his duty at the S.B.S., (Spot. Exp. Scheme), Coimbatore on 13-1-50.
5. Chemist—Shri K. V. Gopala Iyyar (Additional Staff Scheme).
6. Plant Physiologist—Miss R. Shah (Sugarcane Physiology Scheme).

Agricultural Sub-Station, Karnal

1. Agronomist In-charge Shri S. Sen, M.Sc.
2. Asstt. Agronomist—Shri B. D. Ganguli, B.Sc. (Agr.)
3. Asstt. Agronomist—Shri Y. C. Gupta, B. Sc.(Ag.) upto 3-1-50.
4. Asstt. Agronomist—Shri S. L. Relwani, B.Sc. (Ag.) from 15-12-49.
5. Cattle Supdt.—Shri J. D. Sampat Kumaran, L.V.P., M.A., Ph.D. Relieved of his duties on 10-2-50 for taking up a post under the M. P. Government.

Botanical Sub-Station, Pusa

1. Superintendent—Shri M. D. Nandkeolyar, M. Sc.

APPENDIX II

Training of students and research workers during 1949-50.

(*a*) List of students awarded the Post-graduate Diploma.

Division of Botany

Name of Student	*Subject of thesis*
Purshotam Das Bhargva	Study of grain size, weight and number in wheat, with special reference to the needs of the wheat breeder.
Raghunath Prasad Sharma	Studies in some extracted types of wheat in the interspecific cross between *Triticum Vavilovi* and *Triticum Spherococcum.*
Birendra Lal Baruah	Studies in the auto-tetraploids of chillies :— (*a*) Chromosome behaviour in the progeny of tetraploid. (*b*) Fertility in the intervarietal autotetraploid crosses.
Mukund Waman Hardas	Studies in the auto-tetraploid of *Eruca sativa* :— (*a*) Chromosome behaviour in the progeny of tetraploid and one of the group crosses. (*b*) Study of the progeny of the terta-ploid—diploid crosses.
K. P. Pillay	Studies in drought resistance in wheat :— (*a*) Effect of soil drought at different stages of growth. (*b*) Effect of soil drought on the relation between the moisture content and growth of the ear.
Gyanendra Verma	Effect of plant hormones of growth and development of wheat.
Monkombu Sambasivaw Swaminathan	Cytomorphological studies in the collection of non-tuberiferous *Solanum* spp.

Agronomy Division

Atma Govind Prasad	Effect of Bhusa buried with artificial fertilizers on the yield of wheat.
Baijnath Prasad Tiwari	Building up soil fertility by growing phosphate manured berseem in rotation with guar.
Kailash Swarup Shroti	Response of senji to fertilizer treatments and comparison of after-effects with direct manuring on cereals.
Krishnachandra Mohapatro	Response of gram to fertilizer treatment and comparison of after-effects with direct manuring on cereals.
Mata Din Misra	Effect of N. P. K. and Ca at different levels and in various combination on wheat.
Narayan Pandharinath Sinarkar	Building up soil fertility with different green manures and oil cakes in combination with different fertilizers.
Tara Chand Sharma	Studies on the comparative effects on placed and broadcast fertilizers on the yield of berseem fodder and seed.
Diwaker Ganpati Dakshindas ..	Studies on the effect of different fertilizers on the associated growth of legumes and cereals.
Kesho Shrwanji Yawalkar	Studies on the (*i*) effect of different fertilizers on fodder yield and quality of Rhodes grass-lucerne mixture and (*ii*) effect of ley under different treatments on production of cereal crops.
Ram Avtar Gupta	Effect of different forms of phosphates on berseem and residual effect on maize.
Chaitanya Patro	Response of peas to fertilizer treatments and comparison of after-effects with direct manuring on cereals.
Ramesh Chandra Garg	Effect of different types of cultivation, placement of fertilizers and their time of application on the growth and yield of sugarcane.
Rameshwar Prasad Agarwal ..	Relative value of nitrogen in inorganic fertilizers and organic manures on wheat.

Name of student	*Subject of thesis*
Chandra Prakash Trivedi ..	.. Building up soil fertility through organic manures and artificial fertilizers with and without a legume in the rotation.
Raj Bans Singh	.. Response of cowpeas to manurial treatment and residual effect on wheat
Niranjan Singh Verma ..	.. Response of methra to fertilizer treatments and comparison of after-effects with direct manuring on cereals.
Chandar Bhan Singh ..	.. Studies on the growth, yield and sucrose contents of different varieties of sugarcane.
Sunder Singh	.. Effect on various doses of phosphatic fertilizers with potash and/or nitrogen on berseem and study of the residual effect on maize and wheat.
	Chemistry Division
Phani Bhusan Bhattacharya	Profile studies on the soils of Delhi.
Tinkari Das	Electro-chemical characteristic of clays and base exchange of properties of soils of Jubbulpore profiles.
Umesh Chandra Padhee	Profile studies on the soils of Karnal.
V. S. Subramanian	Studies of clays and free iron, aluminium and silica in the profiles of Cutch soils.
Paresh Chandra Ghosh	Studies of mineral elements of the leaves and of growth-characteristic of yield of wheat of the old permanent manurial plot of Pusa.
Parkash Chand Thakur	Effect of addition of various phosphatic fertilizers on the microbial activities of acid, neutral and calcarious soils.
	Entomology Division
Achyut Chandra Barbara	Biology of *Euproctis lunata*, its parasites and its control.
S. Krishnaswamy	Studies on the toxicity of D. D. T. and Y-BHC to some insect pests of storage and agricultural crops.
Murari Lal Goel	The effect of low temperature upon viability, longevity, fecundity and sex-ratio of parasite *Trichogramma evanescens minutum*.
Rishi Ram Rawat	Development of peritrophic membrance in acridiadae.
Hari Mohan Lal Srivastava	The effect of temperature on insect susceptibility to insecticidal dusts.
Ujala Singh Tomar	The effect of temperature and humidity on the longevity, fecundity and sex ratio in *Microbracon gelechiae*, a larval parasite of *Gnorimoschema Operculella*.
	Mycology Division
K. V. Srinivasan	1. Linseed wilt.
	2. Lentil wilt.
Triloki Nath Kaul	1. Study of *Penicillium notatum* and *Penicillium chrysoganum* with reference to production of *Penicillium*.
	2. Damping of tomato.
Tarini Kanta Goswami	1. Rust of Alfalfa.
	2. Rust of clover.
K. B. Pesharodi	1. Soyabean wilt.
	2. Pea wilt.
Indra Narain Tandon	*Helminthosporium* on oats.
Abir Chandra Jain	Pigeonpea wilt; Inhibitory effect of certain micro-organisms on growth on parasitic activity of *Fusarium udum*.
Sardar Behari Lal	1. Properties of bottle gourd mosaic virus and its identity.
	2. Mosaic of *Capsicum annum*.
Bimalendu Gangopadhyay	1. Foliar necrosis of potato.
	2. Yellow mosaic of bean.

(b) Students admitted during the year

Agronomy Division

1. R. P. Srivastava.
2. S. D. Nimkar.
3. S. K. Nigam.
4. Pandurang Konduji Khedeker.
5. Rang Behari Lal Bharadwaj.
6. Rameshwar Dutt Kanohit.
7. Sharang Dhar S. Pathak.
8. Sardar Singh.
9. Amiya Kumar Choudhury.
10. Lingraj Misra.
11. P. Kumar Panigrahi.
12. Sushil Chandra Choudhury.
13. Lal Behari Singh.
14. Chattar Singh Serohi.
15. Shiva Sahai Awasthi.
16. Shyam Prasad Sharma.
17. Chandra Bhal Agnihotri.
18. Ram Kumar Sharma.
19. Sugrin Singh Tewari.

Chemistry Division.

20. S. Perumal.
21. Patwari Ambadas Rao.
22. Namdeo Marotra Nimgade.
23. Mohd. Farooque.
24. Ajit Kumar Pradhan.
25. Mahtur Singh Rawat.
26. Chandra Pal.

Botany Division

27. Aumosh Chandar Nigam.
28. A. K. Rajapadmanabhan.
29. Hari Krishan Jain.
30. Narayan Yadao Deshmukh.
31. Manmohan Ahluwalia.
32. P. L. N. Somyajulu.
33. Ramanand Patnaik.
34. Shiam Lal Gupta.
35. Wasant Prabhod Sole.
36. B. Suraynarayana Murty.

Mycology Division

37. Naresh Chand.
38. Y. K. S. Murty.
39. Harijindar Singh.
40. V. V. Chenulu.
41. Sushil Kumar Addy.
42. D. V. Goumdaswamy.
43. Shri Gopal Chuturvedi.

Entomology Division

44. M. Govindam.
45. Brija Mohan Patnaik.
46. Virendra Kumar Saxena.
47. Ram Sarup Bhatnagar.
48. Pitambar Singh Duhan.
49. S. B. Lal Gupta.
50. Deveraja Menon.
51. K.C. Choudry.

One year Plant Protection course

52. Gopal Dutt Joshi.

One year sugarcane breeding course

53. Valapat Ramaswami Narasimhan.
54. R. Chandrasekharan.

(c) Students admitted for short course of training—

Name	*Division*	*Period*
1. C. R. Venkatraman	Chemistry	6 months.
2. K. L. Bhagat	Do.	Do.
3. S. P. Gupta	Do.	Do.
4. D. Sharma	Do.	Do.
5. D. V. Krishnarao	Do.	2 months.
6. Mrs. Jasudason	Entomology.	1 month.
7. Sukh Dev Singh	Sugarcane Station, Coimbatore	3 months.
8. J. Veeraraghavan	Botany	7 months.
9. Sinmural Singh	Do.	2 months.

(d) Honorary Research Workers

1. J. S. Rawat	Analysis of trace elements.
2. Mrs. Jasudason	Studies on the biology and fecundity of I. *minutum* and its host *Corcyra cephalonica.*
3. S. Krishnaswami	Toxicology.
4. N. Subramiam	Technique of Bacteriological work.

(e) Research Fellows

1. Jagdish Singh	In Botany Division
2. J. N. Upadhaya	Do.
3. Shree Ram Bhargava	Do.
4. W. M. Hardas	Do.
5. P. M. Joshi	In Chemistry Division.
6. S. Chandra Sekhara	Do.
7. Parkash Chandra Thakur	Do.

National Institute, Research Fellow (Junior)

1. Mr. D. K. Mukherjee, M. Sc., Dipl. Agr. (Cantab). In the Botany Division.

APPENDIX III

List of publications

1. Asana, R. D. & Mani, V.S.	Photosynthesis in the ears of five varieties of wheat. *Nature 163* : 450.
2. Asana, R. D. & Mani, V.S.	Studies in Physiological analysis of yield I. Varietal differences in photosynthesis in the leaf, stem and ear of wheat. *Physiologia Plantarum 3* : 22-39.
3. Asana, R.D. & Malkani, T.J.	On the uptake of nitrogen by three varieties of wheat. *Proc. 37th Indian Sci. Congr.* Sec. VI, Abst. 65, p. 63.
4. Abbasi, F. H.	Inheritance of resistance to stem rust and leaf rust in crosses of Premier and Kenya wheat. *Indian J. Gent. & Pl. Breed. 9* : 7-17.
5. Chatterjee, D.	An interesting case of botanical nomenclature. *Sci. & Cult. 14* : 156.
6. Chatterjee, D.	Notes on two exotic plants from South India. *Sci. & Cult. 15* : 156.
7. Chatterjee, D.	New records of plants from India and Burma. *Kew Bull.* 1949 : 563.
8. Chatterjee, D.	Correct name of Indian Silk Cotton tree. *Indian Forester 76* : 139.
9. Chatterjee, S. N. *et al.*	The San Jose Scale and other scale insects usually mistaken in India, *Indian J. Ent. 10* (1) : 5-29.
10. Chona, B. L. & Ram Lal Munjal	*Puccinia Kuchnii* (Krueg.) Butler on sugarcane in India. *Curr. Sci. 19* (5) : 151—152.
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12. Dabadghao, P. M.	Seed setting in Kudzu vine. *Curr. Sci. 18* (10) : 179.
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16. Idnani, M. A.	Use of sulphate of ammonia as fertilizer with special reference to Sind. *Indian Farming 10*(1) :
17. Mukerjee, J. N.	Trace element deficiencies in citrus. *Sci. & Cult.* Nov., 1949.
18. Mukherjee, S.	Structure and function of Bursa-Copulatrix and the associated organs in Bruchidae (Lariidae) Coleoptera. Phytophaga and their taxonomic significant. Curr. Sci. July 18, 1949, pp. 255-257.

19. Mukherjee, S. & Chatterjee, S. N. — *Diaretus aphidium* sp. n (Hymenoptera, Aphidiidae) a parasite of *Pterochlorus persicae* on *Prunus persica* in Baluchistan. *Proc. R. Ent. Soc. London.* (B) *19* (1—2): 4—6, Feb., 50.

20. Pal, B. P. & Butany, W.T. — Influence of late sowings on yield and other plant characters in wheat and the possibility of breeding varieties specially for late sowing. *Indian J. Genet. & Pl. Breed. 7* : 43—54.

21. Pal, B. P. — Some aspects of wheat improvement in India. *Indian J. Genet. & Pl. Breed. 8* : 59—67.

22. Pal, B. P. — Plant breeding. *Indian J. Genet. & Pl. Breed. 9* : 1—6.

23. Pal, B. P. — Tackling the food problem. *Indian Farmg. 10* : 149—51:

24. Pal, B. P. & Singh, H. B. — Hybrid brinjals give increased yields. *Indian Farming 10* . 378—80.

25. Pal, B. P. & Singh, H. B. — Plant Introduction reporter—I. *Indian Farmg. 10* : 423—32

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32. Rattan Lal — Biological observations on *Empoasca kerri* var. motti on potato plants. *Indian J. Ent. 8* (2): 195—201.

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34. Do. — Soil conservation survey and land use classification. *Indian Farming 10*—138.

35. Singh, H.B. & Pal, B. P. — Some observations on the interspecific cross *Luffa acutangula* Roxb. × *L. cylindrica* (Lour) Roem. (=*L. aegyptica, Mill*). *Proc. 36th Indian Sci. Congr. Sec.* X, Abst. 17 P- 196.

36. Vasudeva, R. S. & Iyengar, M.R.S. — Mode of transmission of the long smut of jowar. Curr. Sci. 19 (4) : 123.—124.

37. Vasudeva, R.S. & Iyengar, M.R.S. — Secondary infection in the bajra smut disease caused by *Tolyposporium penicillariae* Bref. *Curr. Sci. 19*(4) : 123.

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39. Vasudeva, R.S., Garga, R.P. & Azad R.N. — Necrosis in tomato (*Lycopersicum esculentum* Mill). *Curr. Sci. 18 (11)* : 411—413.

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